April 1979
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kilobaud

MICROCOMPUTING

Sherry Smythe reviewing INSTANT SOFTWARE.

Here it is at last... THE FIRST FLOPPY DISK BASED COMPUTER FOR UNDER $1000

The C1P MF $995

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The Challenger 1P Mini-disk system features Ohio Scientific's ultra-fast BASIC-in-ROM, full graphics display capability and a large library of instant loading personal applications software on mini-floppies including programs for entertainment, education, personal finance, small business and now *home control!*

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You can move up to mini-disk performance at any time by adding more memory and the disk drive. Contact your local Ohio Scientific dealer or the factory today.

*Both systems require a video monitor, modified TV or RF converter and home television for operation. Ohio Scientific offers the AC-3 combination 12" black and white TV/monitor for use with either system at $115.00 retail.

All prices, suggested retail.

OHIO SCIENTIFIC

1333 S. CHILLICOTHE RD., AURORA, OHIO 44202 (216) 562-3101

The Microcomputers you should take seriously.

The C3 Series is the microcomputer family with the hardware features, high level software and application programs that serious users in business and industry demand from a computer system, no matter what its size.

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Ohio Scientific now offers the 6502C microprocessor with 150 nanosecond main memory as the GT option on all C3 Series products. This system performs a memory to register ADD in 600 nanoseconds and a JUMP (65K byte range) in 900 nanoseconds. The system performs an average of 1.5 million instructions per second executing typical end user applications software (and that's a mix of 8, 16 and 24 bit instructions!).

Mini-system Expansion Ability.

C3 systems offer the greatest expansion capability in the microcomputer industry, including a full line of over 40 expansion accessories. The maximum configuration is 768K bytes RAM, four 80 million byte Winchester hard disks, 16 communications ports, real time clock, line printer, word processing printer and numerous control interfaces.

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The C3 systems have phenomenal performance-to-cost ratios. The C3-S1 with 32K static RAM, dual 8″ floppies, RS-232 port, BASIC and DOS has a suggested retail price of under $3600. 80 megabyte disk based systems start at under $12,000. Our OS-CP/M software package with BASIC, FORTRAN and COBOL is only $600. The OS-DMS nucleus package has a suggested retail price of only $300, and other options are comparably priced.

To get the full story on the C3 systems and what they can do for you, contact your local Ohio Scientific dealer or call the factory at (216) 562-3101.

The C3 Series from Ohio Scientific.

C3-B wins Award of Merit at WESCON '78 as the outstanding microcomputer application for Small Business.

OHIO SCIENTIFIC

1333 S. Chillicothe Road • Aurora, Ohio 44202

PUBLISHER'S REMARKS

Wayne Green

St. Louis Computerfest

The first microcomputer show in the St. Louis area will be held Saturday, March 31, at the Cervantes Convention Center. This combination hamfest and computerfest should bring in a good crowd.

For exhibition information call Bob Heil at (618) 295-3000 or 3030. Booth costs are reasonable and several local dealers have already signed up to exhibit, as has Southwest Technical Products. *Kilobaud MICROCOMPUTING* will be there, and I will be giving a talk on making money in microcomputing . . . something with which I am not unfamiliar.

During the day before the show I'll be talking about it over many of the radio stations and TV stations in St. Louis. They have a rather full schedule of interviews set up for me, so we may bring out a good bunch of people. I'll be emphasizing the importance of microcomputers for small-business applications, so please have small-business demonstrations available for them to back me up.

The show is being supported by a consortium of 22 ham and computer clubs in the area.

The New Cover

No one said anything much about the covers for the last couple of years—except the computer stores, and they were essentially in agreement that the plain cover was not helping them sell magazines. I liked the 1977 covers and agreed, without enthusiasm, to go along with the changes made in 1978. The 1979 covers were my idea, and I'll explain why I made such a radical change.

The fundamental idea was to try to have the magazine serve the market that I perceive. Toward that end I've been a little slow in reacting. In mid-1977, I wrote that I could see a slowdown in hobby computing. Before I go further I really should define my terms, otherwise I'll have all sorts of arguments.

My concept of the microcomputer hobbyist is a person who buys either a kit or an assembled microcomputer and proceeds to pursue the hardware end of things with a vengeance. This person reads voraciously about microcomputers and soon knows all about memory mapping, memory expansion, various interfaces, printers, monitors. Exploring inside the computer is his fun and hobby. Oh, he's learned BASIC, but he also enjoys machine and assembly programming. For the most part he hasn't written any monumental programs, but he can sit down and whip off a quickie to bring up any needed function on demand.

Then we have the programmer-type person. The programmer has a general idea of the hardware . . . just what he needs to make do with his programming. His joy is sitting down and writing a neat program, with a minimum of coding, to accomplish some task. This person will, I think, be the savior of microcomputing—if we can harness him to write the programs our microcomputers need for action.

A third type of "hobbyist" is the dilettante. This person has bought a microcomputer and wants to use it for fun. He doesn't want to have to learn what signals are on what bus lines; he doesn't want to have to sit for two months and write an intricate program; he wants to use the system and enjoy it. Oh, he wants to learn the rudiments of hardware, but he's not a fanatic. He also wants to be able to write simple programs . . . perhaps more to amaze his friends than for practical applications.

Although none of these categories is absolute, the general idea is there. In planning a magazine, a publisher must keep an eye on the interests of the readers and prospective readers. Having heard the crescendo of complaints about super-scientific magazines in our field, I determined not to let *Kilobaud* go in that direction. The original idea was to have a magazine for the relative beginner to computing to read and, thus, learn about computing. I wanted to have most of the articles simple to understand and written, as much as possible, in English. I notice with some smugness that other publications are heading that way now.

The aim of *Kilobaud MICROCOMPUTING* is the same as it was when the magazine started. The main change that has taken place in the field is the entry of more "home computerists," my so-called hobbyist of the third kind. Thus, while the content of the magazine has changed little, the cover and readership have changed. The new cover is aimed at meeting the needs of computer stores, and attracting home computerists, who might otherwise be afraid to even open the magazine and see what is inside.

With one eye on the needs of advertisers, we do try to make sure that the magazine is particularly attractive to the person who is really involved with microcomputing and thus would tend to be a better prospect for microcomputer products.

If this sounds commercial, perhaps it is; but even the most anticommercial reader should recognize that the number of pages of articles he gets to read are determined almost entirely by the number of pages of advertising supporting those articles. No ads, no articles—in fact, no magazine. Witness *ROM, Microtrek* and other failures in the field. In order to have about 50 articles a month, as we have in *73 Magazine*, we need about 100 pages of ads.

There has been much talk during the last year or so about the growing market for microcomputers for small businesses. I suspect that even though an obvious market for such systems exists, it will not be realized until complementary programs exist. In the meantime, I think that a lot of sales that have been credited as being made to small businesses have been to home computerists who have been rationalizing the cost of the system on the strength of its eventual value as business equipment.

In line with this concept, we've been including some business-oriented programs in the magazine. This has been working, according to our recent polls, because we are gaining a substantial number of business-oriented readers who are looking to *MICROCOMPUTING* as a way to understand computers and to keep up with hardware and software availability. The beginner-level articles are perfect for this new type of reader. This obviously benefits the advertisers since this new group has both the money and the interest to buy what is needed.

The name change from *Kilobaud* to *MICROCOMPUTING* is part of the same concept of general change in the entire field. Far too many of the newcomers not only had never heard of a kilobaud, but were afraid of one. So, rather than constantly explain about high-capacity data channels, I decided to change to a name more in keeping with the way the field has been growing.

Now get off our back and enjoy the articles . . . that's the main purpose of all this. There are now close to one hundred people working hard to put out a magazine that you will both enjoy and find educational. If you're in southern New Hampshire, please stop by and see what it takes to put out a magazine of this size every month. We do everything here except print and mail the magazine, which are done in Connecticut. We edit the articles,

Reader Responsibility

One of your responsibilites, as a reader of *Kilobaud MICROCOMPUTING*, is to aid and abet the increasing of circulation and advertising, both of which will bring you the same benefit: a larger and even better magazine. You can help by encouraging your friends to subscribe to *Kilobaud MICROCOMPUTING*. Remember: Subscriptions are guaranteed—money back if not delighted, so no one can lose. You can also help by tearing out one of the cards just inside the back cover and circling replies you'd like to see: catalogs, spec sheets, etc. Advertisers put a lot of trust in reader requests for information. To make it more worth your while to send in the card, a drawing will be held each month and the winner will get a lifetime subscription to *Kilobaud MICROCOMPUTING*!

The latest winner of a lifetime subscription to *Kilobaud MICROCOMPUTING* can be found under the "contest" logo on page 8.

set the type, draft the schematics, paste it all up, shoot the negatives, sell the ads and put them together. It's quite a complicated process, which also includes packing and shipping back issues, books, tapes; maintaining buildings and grounds—you name it.

That's probably a lot more than you ever wanted to know about the magazine, but, anyway, it helps explain the cover changes and the general concepts we've been using for guidance.

The Saga of Glenwood Springs

Unless you've driven to Aspen, the chances are 99 out of 100 that you've never heard of Glenwood Springs, Colorado. On the other hand, if you've ever tried to fly into Aspen the chances are about the same that you've had to drive to Aspen and, thus, inevitable that you've driven through Glenwood Springs.

For four years now there has been an annual ham-industry meeting in Aspen during the second week of January. Manufacturers, dealers and the media have been getting together for a week of retrospection, introspection . . . and skiing. I don't recall either Rocky Mountain or Aspen airlines ever being able to honor their confirmed reservations from Denver to Aspen during the four years.

What does all this have to do with microcomputing? Attendez, s'il vous plait . . . I'll get to that.

During a dinner meeting this January at the Copper Kettle in Aspen, an advertising agency handed out brochures pitching ham-industry accounts. The waiter took a look at one of the brochures in my hand and asked me if I was a ham. I said yes and he asked my call letters. I turned my belt buckle with my call on it upwards and read off "W2NSD/1." The waiter laughed and introduced himself as Fred, WB0FOR, the chap who had made my belt buckle for me (Colorado Silver Company) and who was an advertiser in *73 Magazine*.

Since most of us had walkie-talkie ham transceivers, we asked Fred what repeaters were in the area. The only usable one was in Glenwood Springs on 146.67 MHz.

The next day I called in through the repeater with my HT while eating lunch at Tiehack, and I talked at length with Bob, K9MWM/0. When I asked him what kind of business he was in Bob said he was writing computer programs for the TRS-80 for a living. You should not be surprised to know that he came skiing with us the next day and we talked at length about the programs he has written and sold in Glenwood Springs. I think you'll find some of them being released by Instant Software before long, and perhaps Bob will be able to do a bit more skiing as royalties make life easier for him.

Did I luck into the *only* programmer in the world who has moved to a small town to write microcomputer programs for a living? If there are any others, they would do well to get in touch with a microcomputer-programs publisher such as Instant Software and see about getting their work sold by the thousands for a royalty. It isn't much more difficult to sell a thousand programs than one, and the profit is of a different order of magnitude.

With Instant Software already producing one new computer program package per day, it appears that this group is going to be the largest in the field by a wide margin. The group is aiming at being able to produce five new program packages per day by the end of this year—that's over 100 per month!

In addition to game and home-type programs, an unlimited number of specialized business programs is required. Printers need a program that will estimate printing costs for them. Radio stations need a program to print the program log and tell salesmen what spots are available . . . and for how much. Garbage-collecting firms need truck routing and billing programs. The list is almost endless.

Will we start to see some sharp characters emerging as programmer's agents for 10 percent of the action? If programmers don't wake up to the bonanza that is out there waiting to be plucked, then agents will get a piece of the action. These agents will be worth their efforts—at least at first—until programmers find out what is going on in the real world.

That chance contact in Glenwood Springs was well worth the entire trip. And if my telling about this experience wakes up a few more programmers, all of us will benefit. Dealers will have more programs to help them sell systems. Manufacturers will thus benefit too. About the only thing limiting the sale of microcomputers today is the need for good programs—and that hasn't by any means stopped sales.

OUTPUT FROM ISI

Sherry Smythe

"What kind of programs do you need?" is the question we most often hear. If you are talking about types of computers, the obvious fact of life is that the more computers a firm sells, the more programs that will sell for that system. In addition to the top three sellers, TRS-80, PET and Apple, we're planning to support as many systems as seriously desire to be supported with ISI software. So far we've heard from Heath and OSI.

If you mean the subject matter of the programs, the three most needed types are business, business and education. We've just finished a Bowling League Secretary program for the TRS-80. With over 10,000,000 league bowlers, that should sell well. Then there is a Little League Manager program package for the several hundred thousand little-league teams. This one is written for the PET. Do those give you any ideas?

For some time I've been asking for a good cribbage game. How about a bridge tutorial for beginners? The need for educational programs is endless. There are languages, history, geography and math to be taught . . . no end to it. But don't go off into left field in programming; stick to things that you know or can easily check on.

When you submit a program, be sure to mark everything with your name and address, the type of computer it uses, how much memory it takes—and overdo the documentation. We're still getting an occasional cassette with no paperwork at all; some don't even tell us what system to try them on! With over a thousand programs in the works there is no time for guessing games—unless they are programmed as such.

kilobaud T.M.
MICROCOMPUTING

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Cover: Executive Vice President Sherry Smythe reviewing Instant Software in the ISI Micro-lab. (Computers shown left to right: TRS-80 running Flight Simulation, Heath H 8, PET and Apple displaying Golf program.) (Photo: Tedd A. Cluff)

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INCLUDE OLD ADDRESS AND ZIP CODE WITH ADDRESS CHANGE NOTIFICATION.

While most program packages are being priced at $7.95, some of the longer and more complex programs will be priced accordingly. We have business packages scheduled to cost $350 and $695. Some shorter programs, such as the six on our Demo I package, are ganged up to make a $7.95 package.

Some programs rely upon extra hardware for operation. We have a small audio amplifier and speaker that plugs into the PET and adds sound to some game programs. This will soon be available. If your program needs a piece of hardware to function, we'll organize that too.

Quite a few readers have written to ask about our investment opportunity. If you're interested in making as much as 15 percent on your money, write to Sherry Smythe, Investments, Instant Software, Inc., Peterborough NH 03458.

Have you written a truly good original program that you think lots of people will buy? Write to: Instant Software, Inc., Peterborough NH 03458.

Contest!

Votes are in and tallied for winner of the "best article" for January 1979. That winner is Frank B. Rowlett, Jr., author of "TRS-80 Tape Controller."

Congratulations, Frank.

Other contest winners are Bill Daly of Rochester NY (book) and John Watters of Baton Rouge LA (lifetime subscription).

Congratulations, all.

PET-POURRI

Len Lindsay

Support for the PET computer has been phenomenal in spite of Commodore's lack of commitment. And it will only improve. In the next months, I will be giving you details on products and programs that already exist, such as Speech. Yes, I have heard a PET say two complete sentences in perfectly clear English. I also have heard beautiful music in eight voices, and I have seen excellent machine-language programs such as a Trace program. The PET is still only beginning to develop.

PET Accessories

I just have seen Midland Micronics' (Oakfield House, Station Road, Dorridge, Solihull, W. Midlands, England) announcement of their MM3 Mini Floppy Disk System. The dual drive sits on top of the PET with one drive on each side of the monitor. It looks as if the PET came that way. Price is 1300 pounds or 870 pounds for just a single drive. (Currently, a pound is worth about two dollars.)

For $24.95 you can get a light pen from 3G Company (Rte. 3, Box 28A, Gaston OR 97119) that plugs into your user port.

Connecticut Microcomputer (150 Pocono Rd., Brookfield CT 06804) is marketing AIM16, 16 8-bit analog inputs for the PET. Uses include measuring, recording or controlling temperature, pressure, humidity and light. Prices begin at $159.

Nestar Systems (810 Garland Dr., Palo Alto CA 94303) has announced the Cluster/One System. It includes two IBM-compatible 8-inch diskettes holding up to 315,000 bytes each. This central unit (the Queen) can connect to up to 30 microcomputers. It originally supported the PET, and now allows both PETs and Apple IIs to be connected. Prices begin at $4500 and vary with options and configuration.

If you would like a carrying case for your PET, Pacific Data Products (3835 E. Olivo Ct., Camarillo CA 93010) has one for $66, shipping prepaid to contiguous U.S. It features three handles, lock and take-apart hinges.

Publications

The Microcomputer Resource Center (1929 Northport Dr., Room 6, Madison WI 53704) has published *The Best of the PET Gazette*. This 100-page publication includes over 100 reviews of PET products, 20 program listings and addresses of virtually every company marketing PET products, as well as informative articles and comments. It retails for $10 and is available from your PET dealer or directly from the Microcomputer Resource Center. Regular issues of the *PET Gazette* magazine are free. Send a large (9 × 12) self-addressed envelope with 41 cents' postage for a copy of the next issue.

Micro (PO Box 3, Chelmsford MA 01824) is a bimonthly magazine for 6502 systems (including the PET, KIM and Apple). A subscription is $6 per year. Every issue contains several articles useful to PET users.

Calculators/Computers (PO Box 310, Dept. P, Menlo Park CA 94025) is a bimonthly magazine emphasizing educational uses of computers and calculators. Each issue has articles of interest to PET users. A one-year subscription is $10.

Computer Cassettes Reference List by Robert Purser (PO Box 466, El Dorado CA 95623) is published quarterly and lists virtually all available software for the PET, Apple and TRS-80. One-year subscription: $12.

TIS (PO Box 921, Los Alamos TX 87544) has just published their *PET Workbook #6*, "PET Control and Logic Statements." It explains logical and relational operations, character codes, number systems, symbols and branching techniques. Price is $3.95.

You should be aware of four other books. Sybex (2020 Milvia St., Berkeley CA 94704) has announced two new books: *Microcomputer Programming: 6502* by R. Zaks, $9.95, and the *6502 Applications Book*, $12.95. Dilithium Press has *32 BASIC Programs for the Commodore PET Computer* by T. Rugg and P. Feldman, $15.95. These programs are also available on five tapes at $9.95 per tape. Addison-Wesley Publishing just announced *Programming a 6502 Microcomputer* by C. Foster, $9.95.

Unbelievable as it may seem, Osborne & Associates (630 Bancroft Way, Berkeley CA 94710) are selling 74 programs on tape ready to load and run in your PET for $10. These programs are adapted from Osborne's book *Some Common BASIC Programs* ($8.50). I have a copy of the tape, and it loaded just fine.

Software Worth Mentioning

I was fortunate to receive a review copy of Tanktics by Pleiades Game Co. (202 Faro Ave., Davis CA 95616). I am impressed by their battle-simulation game. Since it is unrealistic to graphically represent a 24 × 32 hexagonal gameboard on the PET screen, then have a PET game package for $15. This includes a 17 × 22 inch map, players' manual, 31 playing counters and two-segment Tanktics program on tape (first segment is in machine language). In this simulation it's you against the PET. The PET keeps track of all the pieces, decides the outcome of battles and has its own strategy of play. Since the game is realistic, you never know where the PET has its tanks until one of your tanks sights one. The PET gives you a list of your sightings at the beginning of each turn. As you move your pieces on the board, you type in your moves to keep the PET up to date on your locations.

This game is a must for anyone who likes war games as sold by Avalon Hill and others but often can't find someone to challenge. I hope more games of this type become available soon. How about someone writing a program for the game Risk?

The Pak series by the *PET Gazette* is an excellent buy: six good programs for only $10. The Pak 1 series includes seven sets of six programs grouped by topic.

The seven topics that constitute the Pak series are titled: Educational Pak 1, Games Pak 1, Music Pak 1, Useful Pak 1, Utilities Pak 1 and Demo Pak 1. Finally, there a comprehensive Best of Pak 1, which makes seven. Details of each follow.

Educational Pak 1 includes a Morse Code Tutor and Math Story Problems. Games Pak 1 includes a fantastic version of Mastermind. Music Pak 1 is compatible with the *PET Gazette* conventions using user-port pins M and N. Useful Pak 1 includes a complete word-processor program. Utilities Pak 1 has a versatile renumbering program in machine language. It renumbers all GOTOs, GOSUBs, ON GOTOs, ON GOSUBs, IF THENs and RUNx's (the lowercase x symbolizes any line number). Demo Pak 1 includes a complete 3-part data-entry demonstration. Best of Pak 1 includes the best program from each category.

All tapes are highest-quality Agfa from Germany and are guaranteed to load and run or be replaced free.

Keep your eye on Programma Consultants (3400 Wilshire Blvd., Los Angeles CA 90010). This company is growing rapidly and already includes some of the BEST professional PET programmers. Their programs will all be fully supported, including corrections if needed. The *PET Gazette* has arrangements to preview their new programs as they are announced. Exciting things are brewing!

Group Project

If your PET users group would like a project that will allow members to help others and enjoy themselves at the same time, this might be for you.

Contact your city's hospital administrators. Advise them of your willingness to help cheer up the children there. Your members could take turns visiting the children evenings, weekends or whenever arrangements could be made. Of course they could bring along their PET. Soon the hospital would probably consider owning its own PET. To make it easy to implement this project the *PET Gazette* offers a package of six games absolutely free if requested by your hospital's volunteer-services director on hospital letterhead. Request Children/Hospital Games.

```
 0 REM***5 'PI' FIND / CORRECT / SELFERASE -BY LEN LINDSAY FOR UNLISTABLE LINES
 1 FORZ=1024TO1999:IFPEEK(Z)<>255GOTO4
 2 FORX=1TO4:IFPEEK(Z+X)-255THENX=4:NEXTX:Z=Z+5:GOTO4
 3 NEXTX:POKEZ,0
 4 NEXTZ:?"[CLR,2DOWN]":POKE525,10:FORI=1TO4:PRINTI:POKE526+I,13:NEXTI:PRINT"[HOME]":EN
READY.
```

Example 1.

```
 0 REM 'PI' FIND USING LINK ADDRESSES
 1 X=1025:REM FIRST LINK ADDRESS--NOTE LINE 5 ERASES THESE 5 LINES
 2 IFPEEK(X)=0THEN5:REM LAST STATEMENT
 3 IFPEEK(X+4)=255THENPOKEX+4,0
 4 X=PEEK(X)+(PEEK(X+1)*256):GOTO2:REM GET NEXT LINK ADDRESS
 5 POKE525,5:PRINT"[CLR,2DOWN]":FORZ=1TO5:POKE526+Z,13:PRINTZ:NEXTZ:PRINT"[HOME]":END
READY.
```

Example 2.

Games may change but will probably include Blackjack, Hangman (sound), Chase (sound), Snake, Stars and Tommy Termite. All are on Agfa tape ready to run. Please keep me informed of any projects your PET group may have.

Tips

It seems that the "lost-cursor syndrome" is a major problem with PETs. There are several solutions. You can get a new ROM from Commodore (called 019 ROM) for $15. This will correct the problem. Or just avoid editing any lines near the bottom of your screen since this is a major cause of the lost cursor. For fun, the *PET Gazette* has a program that gives you *two* cursors at once.

Protect Your Program

Here is an easy way to prevent anyone from listing any lines of your program that you choose (or the whole program for that matter). The program will still run; it takes an additional five bytes per protected line. To get an idea of what I'm talking about, type in this short one-line program:

10πππππ?"TEST"

Make sure you try it; one minute is all it takes. Type it just the way it is listed. There are five pi's between the line number and the first command. Make sure to include them! Now list your program. Line 10 should list for you. The five pi's should still be there right after the line number and one space. Now there's just one thing left to do. Type in POKE 1029,0.

That was the magic word. Now list your program. Notice that line 10 is not listed. Run it to show that it is still there.

Here is what's going on: You should have read and understood Mike Stone's article on program overlays to understand what is happening (see page 56 of *The Best of the PET Gazzette*), but even if you don't understand, you can still easily use this, as I will soon show you. Location 1029 is where your program's first line begins (1024 is 0; 1025 and 1026 give the forward chain; 1027 and 1028 give the current line number). I haven't fully figured this out, but here are my suspicions.

Notice that the second page of Stone's article (1/3 down the right-hand column) reads: "Locations 201 and 202 always contain the address of the next instruction (during program execution) . . . actually the location of the 0 between instructions.

"What we are doing is putting in a value of 0 right where our program commands are supposed to start. This confuses the PET while listing your program. I hope someone else will write with a better explanation and further uses or extensions."

Here is all you do to have any line not listed. Type five pi's between the line number and the first command (or insert five pi's into an existing line). When every line that you want *not* listed has five pi's correctly placed, run my four-line program—called 5 'PI' FIND/CORRECT/SELF-ERASE—in Example 1. With a few changes, you can relocate it anywhere, but I have it set up to work with any program not using the first five lines. It finds every group of five pi's and changes the first one to a value of 0. (Pi has a value of 255.)

Line 1 sets up a FOR NEXT loop starting at 1024 (where BASIC programs begin) until 1999 (or any other number—the larger the number the more locations will be checked for five pi's;

```
 0 GOTO10:REM1-9 HAVE 5 'PI' AFTER LN#
 1 [5'PI']PRINT"YOU CAN'T SEE LINE 1
 2 [5'PI']PRINT"ONCE YOU GOTO 100.
 3 [5'PI']PRINT"THIS MIGHT BE USEFUL
 4 [5'PI']PRINT"WHO KNOWS???????
 5 [5'PI']FORD=1TO10:PRINT"[9RIGHT,RVS]I KNOW "
 6 [5'PI']NEXTD
 7 [5'PI']REM NEXT LINE WAITS ABOUT 10 SECONDS
 8 [5'PI']POKE513,0:WAIT513,10
 9 [5'PI']REM END OF EXAMPLE OF 5'PI' WHICH  WON'T LIST AFTER A GOTO100
 10 PRINT"[CLR]ANY LINES YOU WISH [RVS]NOT[RVSOFF] TO BE LISTED
 12 PRINT"TYPE 5 'PI''S IMMEDIATELY AFTER THE LINE #"
 15 PRINT:PRINT"THEN ENTER YOUR BASIC LINE AS USUAL
 16 PRINT"IMMEDIATELY AFTER THE 5TH 'PI'.
 17 PRINT:PRINT"RUN THE PROGRAM. THEN ENTER
 18 PRINT"GOTO100      (AND WAIT 10 SECONDS)
 20 PRINT"AFTER LOOKING AT LINES 1 TO 9.
 50 PRINT"[12DOWN]RUN 1":PRINT"[2DOWN]GOTO100[HOME,8DOWN]"
 99 LIST1-9
 100 FORZ=1024TO2000
 200 IFPEEK(Z)<>255GOTO900
 300 FORX=1TO4
 310 IFPEEK(Z+X)-255THENX=4:NEXTX:GOTO900
 320 NEXTX
 500 POKEZ,0
 900 NEXTZ
 999 GOTO1
READY.
```

No-list demo program.

thus it will take longer).

Another, faster way to do this is by following the link addresses and checking only for the first pi and changing it to a value of 0. See Example 2 for its listing.

For your convenience I wrote a short demo program that illustrates very well the principle of what is going on. Simply type it in and run it.

For you experimenters: please note that pi is not the only value that works. Try some others (for example, try the shifted left arrow right above the pi key). Also, please note that a few types of lines will not function. If you have any problems, please write and advise me of these as well as what you did to circumvent them. I hope ideas here can be applied elsewhere with other results.

Send all correspondence to: Len Lindsay, 1929 Northport Dr., Room 6, Madison WI 53704.

LEGAL/ BUSINESS FORUM

Kenneth S. Widelitz
Attorney-at-Law

I have been packaging a complete microcomputer system for the small law office. The system, centered around a word-processor, will include a package for attorney timekeeping, calendar/ tickler file, a "personal citator" and a billing system. The system will sell in the $8000 to $9000 range. Knowing something about law office economics and the cash-flow awareness of sole practitioners and small law firms, I know that in order to successfully market the system it will have to be financed on a lease basis.

Recently, I talked to two local leasing companies with experience in microcomputer leasing. Much of what I learned was expected, but there were a few surprises. The following discussion will look at leasing from both the lessee's and vendor's point of view.

Advantages of Leasing

The first and most obvious advantage of leasing equipment is that rather than utilizing your working capital and paying the entire purchase price up front, you need only make monthly payments. That allows you to keep your cash in the business. In some instances it may not be possible to come up with the cash right now, even though your analysis indicates that the computer will pay for itself in just a few months.

Apart from the cash-flow considerations, there are also tax advantages. If the computer is used in an activity engaged in for profit (see the December 1978 Legal/Business Forum), the lease payments are 100 percent deductible from your taxable income. The leasing companies point out that because the term of the lease can be shorter than the depreciable life of the equipment, lease payments can also give you a faster write-off.

In my conversations with both leasing companies, an interesting (and surprising) item was brought out. I asked whether the leasing company passed the Investment Tax Credit (see December 1978 Legal/Business Forum) through to the lessee as a matter of course. Both leasing companies indicated that they did not pass the ITC through as a matter of course, but would do so upon request. There is no extra fee involved to get the pass-through; one only has to know to ask for it. That struck me as very strange.

Ordinarily, the ITC is 10 percent of the purchase price of the equipment. However, if the life of the equipment is five years or, in this case, when the length of the lease is five years, only two-thirds of that 10 percent is available. Nevertheless, on an $8000 system the ITC would be $528.

Remember that that $528 is cash in your pocket as it is deducted from the amount of tax after the amount of tax owed is determined. I thought that such an item should be a point of negotiation or perhaps enter into the pricing of the lease. However, both companies said that they gave it away upon request. The ITC will definitely be a pitch point in my marketing program and certainly won't be left to the leasing company.

Another consideration is that you will be making lease payments over a number of years. With inflation running the way it is, after a while you will be paying with cheaper dollars.

Let's compare the lease to conventional financing. By conventional financing I mean that you go to your friendly banker and take out a loan in order to purchase the equipment. As pointed out above, since the term of the lease is usually shorter than the depreciable life of the equipment, you get a faster write-off. In addition, you usually will get a longer-term lease than you can a loan. That tends to decrease the monthly payments. Also, when you take out a loan you decrease your available bank credit, which is not the case with a lease. Consider also that only the interest on the loan is deductible, while the entire amount of the lease payment is deductible. The advantage of the loan over the lease is that the effective interest rate for the loan will be substantially less than the lease.

Procedures of Leasing

Both leasing companies that I spoke to specialized in leasing equipment with a value of under $10,000. That is significant because businesses that lease equipment of that relatively small value tend to be relatively small businesses. Both leasing companies' lease (credit) application was aimed more toward the credit-worthiness of the principals in the business than toward the credit-worthiness of the business itself. That is, information such as a principal's social-security number and spouse's name and social-security number were considered to be of utmost importance.

Both leasing companies indicated that they tended to check with the owner's bank rather than get D & Bs (Dunn & Bradstreet reports) on the business. One company asked for the last year's tax return for the individuals involved in the business. Both companies indicated that they usually could make a determination as to the credit-worthiness within 48 hours. Since both leasing companies viewed the approval of the application as one based on the personal credit-worthiness of the individuals in the business, both companies required a personal guarantee of the individuals in the company.

That means that should the company at any time not make the lease payment, the leasing company could go after the individuals in order to be paid.

With the lease (credit) application, both companies required a deposit. One company required the first and last two months' payments; the other company required the first month plus 10 percent of the purchase price. The actual equipment lease used by both companies is similar. Bold letters in both leases proclaim that the lessee acknowledges that the leasing company is not the manufacturer of the equipment nor has anything to do with the performance of the equipment and the warranties that accompany the equipment. Both leases also boldly proclaim that the lease is for the term indicated and is *noncancelable*. The lease also states that while the equipment is, of course, owned by the leasing company, the lessee is responsible for paying all personal property taxes on the lease.

Both companies also required the filing of a UCC-1 financing statement. When the lessee is a corporation, a corporate resolution to lease is also required.

When the vendor installs the equipment, the final document required is the lessee's acknowledgement of receipt and acceptance of equipment. That document, as with the lease itself, lists the equipment that is to be leased and sets forth when the lease begins and how much the monthly payments are to be. The seller of the equipment (the vendor) takes the lessee's acknowledgement along with the vendor's invoice to the leasing company. Those documents are processed and the vendor is paid for the equipment somewhere between two and five days later.

Purchase Option

Another item that surprised me was the purchase "option." Both companies had a plan for a 10 percent purchase option, meaning that at the end of the lease the lessee has the opportunity to purchase the equipment for 10 percent of its original cost. However, nothing about the purchase option is written into the lease or any other documentation. Rather, a very informal side letter is sent by the leasing company to the lessee.

One letter says, in part: "Although we cannot precisely determine in advance what the fair market value would be [at the end of the lease], it has been the experience of the industry that it seldom exceeds 10 percent of the original purchase price of the leased equipment."

Obviously, that letter agreement is not binding on the leasing company. However, the leasing company assured me that it always allowed that lessee to exercise its "option" at the 10 percent figure.

The other company used a different approach. The amount of their deposit was the first month's rent plus 10 percent of the purchase price, which, coincidentally, happened to be the amount of their purchase option. Pursuit of that topic revealed that the "option" was not an option at all—rather, the lessee was required to purchase the equipment at the end of the lease, and the 10 percent "deposit" was merely applied to that purchase.

When I asked why that was done, the reply was, "We're not in the business of selling used computer equipment." The other company indicated that if the lessee did not want to exercise its "option," the company would be very happy to take the equipment and deal it off.

The reason that such a side letter, rather than a formal agreement, is used is because the leasing companies feel that if the "option" is written into the lease, the IRS will look at it and say, "This isn't a lease, it's an installment sale." If the lease were so categorized by the IRS, then the lease payments could not be deducted currently. In that instance, the equipment would have to be capitalized.

Determining the Amount of Payment

The amount of the monthly payment is a factor of the equipment's purchase price, the length of the lease and the rate applied. Both leasing companies would write a lease for equipment worth $8000 for 12 months, 24 months, 36 months, 48 months or 60 months. Obviously, the 60-month lease would provide the lowest monthly payment.

The actual amount of payment is determined by multiplying the purchase price times the rate. The rate varies with the length of the lease. For instance, one company's 60-month rate is .026. The monthly payment for an $8000 system would be $8000 times .026, or $208. The factor used by the other leasing company for 60 months was .029. Therefore, the monthly payment for that company would be $232. Since these two companies show a difference on an $8000/60-month lease of $24 per month, you can see that it pays to do some rate shopping.

The above factors work out to an effective interest rate of about 26 percent and 28 percent, respectively, which seem to be outrageous figures. Both leasing companies justify them by saying that the lessee really doesn't care what the effective interest rate is since he is deducting 100 percent of the payments anyway. Better rates might be obtained by leasing from a bank. However, the bank would probably require more paperwork, take longer to process and be tougher with its credit requirements. Both leasing companies indicated that they would lease to a new company if the personal financial statements of the principals were adequate. Such might not be the case with a bank.

Vendor's Viewpoint

For the vendor, marketing to the end-user by means of equipment leasing is very attractive. The vendor is paid by the leasing company within two to five days from the time of delivery and acceptance. That cuts down considerably on the amount of working capital the vendor needs. Also, once the vendor is paid he is totally out of the picture. He does not have to worry about collection. The leasing company takes care of that. The vendor does not have to do any credit checking. The leasing company processes all the paper.

Both leasing companies I talked to indicated that they took an aggressive position with respect to getting all information required. For example, if a social-security number were missing, rather than hold up the procedure by having the vendor talk to the potential lessee to get the information, the leasing company would take care of such matters itself. Of course, the vendor must provide the warranty support and other assistance and training as promised.

A Final Note

Both leasing companies indicated that the cost of the software would be included in the amount of the lease. The limitation is that the software cost must be in proportion (considerably less) to the value of the equipment or it may not be included. Also, the amount of sales tax can be included in the lease. In the above examples, I have assumed the $8000 figures include the equipment, the software and sales tax.

One leasing company even provided point-of-sale literature on the benefits of leasing in addition to "lease it" posters.

Kilobaud Legal/Business Forum
c/o Kenneth Widelitz
10960 Wilshire Blvd.
Suite 1504
Los Angeles CA 90024

BOOKS BOOKS BOOKS BOOKS

24 Tested Ready-to-Run Game Programs in BASIC
Ken Tracton
Tab Books
Blue Ridge Summit PA
$9.95, 250 pp., hardcover

My philosophy in life is that there can never be too many computer games. This is not to say that I don't use my computer for practical things (this text was prepared using Electric Pencil, for example), but I've always been fascinated by mental challenges and like to think that computer games offer me a chance to hone my skills.

This brings me to the latest book to cross my computer bench: *24 Tested Ready-to-Run Game Programs in BASIC*. What a title! It implies that there might be a "24 Tested Not Ready-to-Run" book, a "24 Untested Ready-to-Run" version and who knows what else? Why not just title the book *24 BASIC Games*?

Actually, as it turns out, there are 24 programs in the book, but I can't agree that they're all games. Three of the programs are plots of equations, two are printouts (the LOVE poster program, for instance), one is a ship-hull-design program and one is a decision-making program. That still leaves 17 games, and not bad ones at that.

Included in the book are Wumpus, Biorhythm, Number Guess, Sink the Sub, Craps and Leap Frog-type programs. If you don't have the listings to these already, these versions, although not extraordinary, are worth putting on your system.

If you're after something different, you might want to check out the Star Warp program in this book. This is not the usual Star Trek program. Gone are the familiar 8×8 matrices and status printouts. In their place we find dialogue. That's right, Sulu, Spock, Uhura and Chekov all give you information to assimilate and use for your decision making. Included among your offensive devices are the Corbomite bluff maneuver, retreats and the usual array of Federation weaponry. Here's a short sample of what to expect:

Sulu: "Sir, I'm picking up a vessel on an attack vector with the Prometheus."

Spock: "Ship's computers indicate that it is the outsider vessel Cthulu under the command of Captain Tweel."

You: "Sound Red Alert, Lieutenant Uhura."

Uhura: "Aye, sir."

With a graphics display and a speech synthesis/recognition board, this program could be reworked into the most realistic Trek-type program yet. The point here, however, is that it's something different and should be of interest to those of you who are tired of zapping Klingons in the old manner.

Other programs in the book include Auto-Rallye, Mouse Hunt, Alien Capture, Bomb Disposal and Hangman. The nature of these games should be evident from their titles. My only quibble with every program in the book is that no real attempts at graphics are made (other than for Hangman), and everything seems to be designed for teletypewriter out-

put. This doesn't bother me too much, as I usually rewrite programs as I enter them, but it might be troublesome to some of you who are used to super graphics in game programs.

You might be wondering about what BASIC the games are written for. It appears that Dartmouth BASIC was used for a majority of the programs. An unusual aspect of this book, however, is that 12 of the best programs are rewritten for the TRS-80 and PET computers (read: Microsoft BASIC). For those not interested in typing everything into their TRS-80, a Level II tape is available from the publisher for $9.95, postpaid.

What's my final opinion of the book? I like games, so I like the book. If you already have *101 Games in BASIC*, this one is probably not worth buying because there are a lot of repeats. If you have a TRS-80, skip the book and buy the tape. If you don't have a book of games to put into your computer, consider this one—it has a bit of the traditional and a bit of the new.

Thom Hogan
Bloomington IN

Digital Computer Logic and Electronics
C. P. Gane, A. W. Unwin
4 Volumes, Softbound
147 pp., $14.95
The Design of Digital Systems
P. C. Pittman
6 Volumes, Softbound
346 pp., $19.95
Distributed by GFN Industries
New York NY

With the ever-increasing interest in digital logic and computers, there is a corresponding need for instructional material on these subjects. In addition to classroom students, many computer hobbyists would like to study at home. *Digital Computer Logic and Electronics* and *Design of Digital Systems* are two self-instructional courses intended for this purpose.

I'll discuss *Digital Computer Logic and Electronics* first and call it the basic course from now on. This four-volume, self-instructional course covers digital logic in its simplest forms. Volume 1, titled "Basic Computer Logic," is actually concerned with the binary and octal number systems: how they work, how to convert from one to the other and how to handle fractions.

Volume 2, more realistically titled "Logical Circuit Elements," discusses AND, OR, NAND, NOR and inverter gates and truth tables. Almost every page in each volume has one or more questions for the student to answer and more than enough space to write the answers.

Volume 3, "Designing Circuits," goes into Boolean algebra and combinations of gates to achieve various functions. Finally, Volume 4, "Flip-Flops and Registers," looks at RS and J-K flip-flops, binary counters and shift registers. Each book ends with a quiz to see how much of the instruction you are actually retaining.

The coverage of each subject is comprehensive and complete. However, I do have some reservations about this course. First, I think that the titles of the course and the first book are not really indicative of the contents. Second, the four volumes total 147 pages, a majority of which are 1/2 to 3/4 blank to allow for answers. Third, nonstandard logic symbols are used for the various gates, which means that the student will have to learn new symbols if he goes on to the advanced course or tries to make use of his knowledge elsewhere. And last, the advanced course, which I shall discuss in a moment, recommends this course as a starter for beginners; yet all of the same basic information is contained in the advanced course as well.

The Design of Digital Systems contains all the instruction of the basic course and covers it in much greater depth. Standard symbols are used, and not much blank page space for answers is to be found. Although it has little more than twice as many pages as the basic course, I estimate that *The Design of Digital Systems* contains five or six times as much instructional material.

In addition to the material I've already talked about, much more is included. Complex gate combinations, arithmetic circuits, memory and counters are explored exhaustively and thoroughly. The quality of instruction is outstanding.

Volume 5 concerns calculator circuits. Encoders, decoders, reading ROM, BCD-to-seven-segment, BCD-to-decimal and more are the subjects explained. How does a calculator read its keyboard? How are the numbers on an LED readout controlled? It's all in this book.

It's in Volume 6, titled "Computer Architecture," that the internal workings of a CPU are brought into focus. Registers, buses, instructions, addressing modes and I/O are explained in detail. Step by step, this volume follows the CPU through its various functions. This volume could be sold separately to those who already have a good logic background.

Computer Logic and Electronics could be improved greatly by using standard logic symbols, eliminating all of the blank space, packaging it into one volume and reducing the price. Even then, the only students that it might be right for would be those who wanted a very basic introduction to the subject with no intention of going further with it.

Design of Digital Systems is definitely the superior course. While I feel that it is overpriced, it is available with quantity or educational discounts. The latter is important because I think that this would make a good classroom workbook. I disagree with the distributors that self-instruction is faster and more thorough than classroom learning.

As stated in a recent advertisement, the cost of these courses is tax deductible (if you can prove that they are a business expense). To entice you, the distributor is offering a 30-day full refund plus return postage if for any reason you are not satisfied. You certainly can't beat that.

Rod Hallen
Tombstone AZ

Star Ship Simulation
Roger Garrett
dilithium Press
Portland OR, 1978
122 pages, $6.95

Star Ship Simulation by Roger Garrett introduces three important ideas to the amateur programmer: (1) the design of a programming project; (2) structured programming; (3) the simulation of an interactive system.

The first two ideas are covered in chapters 1 and 2. For the reader who had hoped to be given a working program, the early chapters might be frustrating, but for the more experienced programmer who wants to advance his skills, they are all too short.

Then we get to the heart of the book, which starts in chapter 3 where all the functions of a star ship are outlined in detail. A "simulation controller," which calls the communications, navigation, sciences, engineering, medical and helm sub-modules, is described.

The various functions of each of these sub-modules is outlined in a structured programming format. The advantage of this, of course, is that the user can implement the logic in any language he chooses. He is free to examine the logical structure and add or delete features. And the logic is more clearly presented than any source code could be. An example of the navigation set velocity submodule is shown in Fig. 1.

In my opinion, this book is a good influence on the space-war computer addicts. Heretofore, we have spent our time programming a universe of Klingons to be destroyed. Only the military capabilities of the star ship have been programmed. *Star Ship Simulation*, on the other hand, while it involves conflict with enemy vessels, sets the pattern for simulating the interaction between the ship's systems. One is, in effect, designing a star ship that works.

The communications console accepts commands and messages, the medical units can be used as a diagnostic challenge, the energy systems must be balanced and optimized, the helm accepts commands and displays messages and so on. The programmer who completes this project will go a long way toward learning some system engineering and not just battle tactics.

The next step might well be learning to provide the challenge of running a star ship without warfare. Such challenges might

(continued on page 21)

```
IF THE SPECIFIED VELOCITY IS SUBLIGHT (0 - .99):
   TURN OFF THE SPACE/WARP ENGINES;
   SET THE OPERATIONAL STATUS OF THE IMPULSE ENGINES
   TO THE REQUESTED SPEED;
   SET THE ENTERPRISE VELOCITY TO THE REQUESTED SPEED.
OR IF THE SPECIFIED VELOCITY IS GREATER THAN LIGHT:
   TURN OFF THE IMPULSE ENGINES;
   SET THE OPERATIONAL STATUS OF THE SPACE/WARP ENGINES
   TO THE SPECIFIED SPEED;
   SET THE ENTERPRISE VELOCITY TO THE SPECIFIED SPEED.
ELSE THE REQUESTED VELOCITY IS INVALID:
   SO NOTIFY THE NAVIGATOR
ENDIF
RETURN//
```

Fig. 1.

Specifications:
S-100 compatible. MFM encoding, 35 tracks with ten 512-byte sectors per track. 179,200 bytes on double density SA-400 and North Star BASIC, DOS, and Monitor included.

For further information, write for full color catalog or contact your local computer store.

New from North Star

Double Density Performance at Single Density Prices

The new HORIZON computer and Micro Disk System now record in double density! That means each new Shugart SA-400 minifloppy disk drive accesses 180K bytes of on-line information. All double density HORIZON computers and Micro Disk Systems have a redesigned controller which allows the use of quadruple capacity disk drives as they become available in early 1979. A three-drive North Star System with quadruple capacity disk drives will access over a megabyte of on-line information. But, best of all there's no price increase for double density models.

North Star BASIC and DOS have been upgraded to accommodate the increased capacity and yet run existing programs with little or no change. The new disk system also supports single density, so existing single density diskettes can still be used. Single density SA-400 drives previously purchased with North Star systems can also be used.

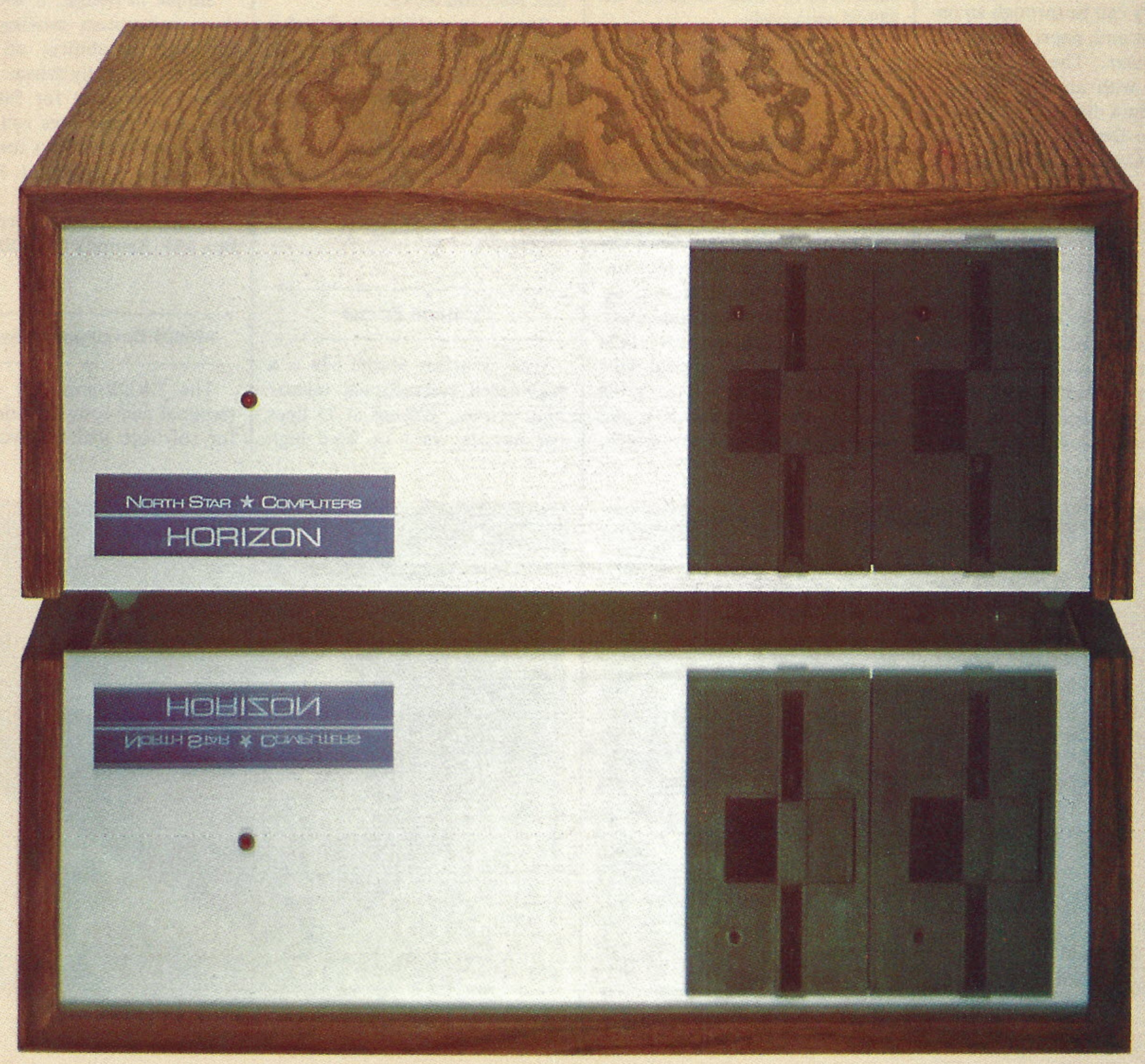
Pricing

HORIZON with one double density SA-400 minifloppy (180K bytes), 16K RAM, Z80A processor and serial I/O port: $1599 kit, $1899 assembled.

MICRO DISK SYSTEM with one double density SA-400 minifloppy, controller board and power regulation: $699 kit, $799 assembled. (Cabinet and power supply $39 extra each.)

NORTH STAR ★ COMPUTERS
2547 Ninth Street
Berkeley, California 94710
(415) 549-0858

N9



NEW PRODUCTS

Edited by Dennis Brisson

ROM/RAM Simulator

The ED-6000 is a ROM/RAM simulator that allows you to develop and test machine code software in microprocessors, bit-slice and minicomputer systems. The simulator features expandable word length beyond 128 bits and includes a Data Monitor to display word lengths in excess of 40 bits. Using the ED-6000, engineers developing mini-micro codes can run their systems at full speed without wasting PROMs and can conduct diagnostic tests on assembly-line systems.

A unique standard feature allows you to address the simulator's memory from either multiple or independent addressing sources in 2K by 8-bit increments. Data entry can be through an optional terminal, paper tape reader or computer. The ED-6000 is available with an RS-232 interface for data display and entry.

Electro-Design, Inc., 7364 Convoy Court, San Diego CA 92111.

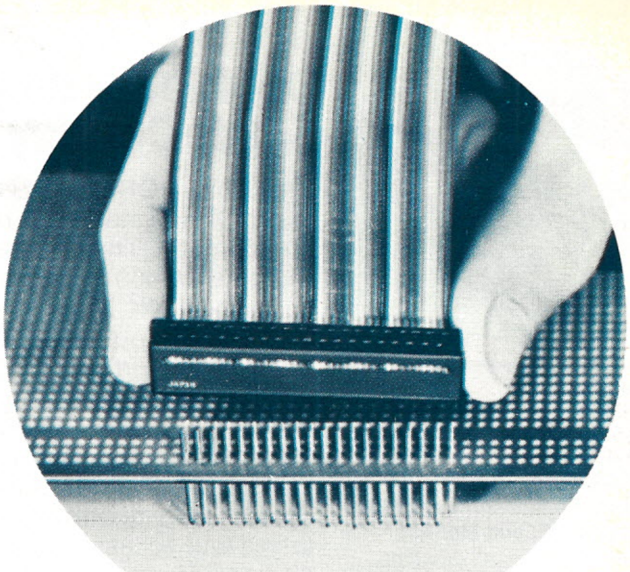
Selector III

Selector III is an interactive, multi-key data base management system that allows users of CP/M-based microcomputers to enter records, update files interactively and provide full query and report writer functions. The system comes with a library of predefined record formats in a data dictionary and programs to manage and report sales activity, inventory, payables, receivables, check register, expenses, appointments and name and address functions. The system supports up to 24 items (fields) per record.

Selector III is distributed on diskette with source code (except for a machine-language key maintenance program). User's system requirements are 48K, CP/M (or derivative), two mini single density drives or one larger capacity drive, terminal or monitor with up-cursor and erase-screen codes and, ideally, a printing device. It operates under CBASIC and costs $295. CBASIC costs $49.95 with Selector, or $89.95 separately.

Micro-Ap, 8939 San Ramon Rd., Dublin CA 94566.

Terminal/Connector Wrap Post



T46-5-9 wrap posts used as male ribbon-wire connectors.

The T46-5-9 is a double-duty wrap post that functions as a terminal for wrapped-wire interconnections or as pins to mate an inexpensive ribbon-wire connector. The 0.025 inch square post is 0.24 inch long on the top or connector section and 0.64 inch long on the bottom. These lengths allow two wire wraps and three wire wraps, respectively, while the sharp square edges ensure gas-tight wraps. The 0.044 inch diagonal center section provides a solid wedge fit in the standard 0.042 inch holes in perforated boards, and the stop bar ensures consistent insertion depth.

In packages of 100, the T46-5-9 posts (tin plated) are priced at $3.58; packages of 1000 are $28.93. The T46-5A-9 posts (gold plated) are $5.97 per 100 and $51.93 per 1000, packaged.

Vector Electronic Co., 12460 Gladstone Ave., Sylmar CA 91342.

Printerm Printer

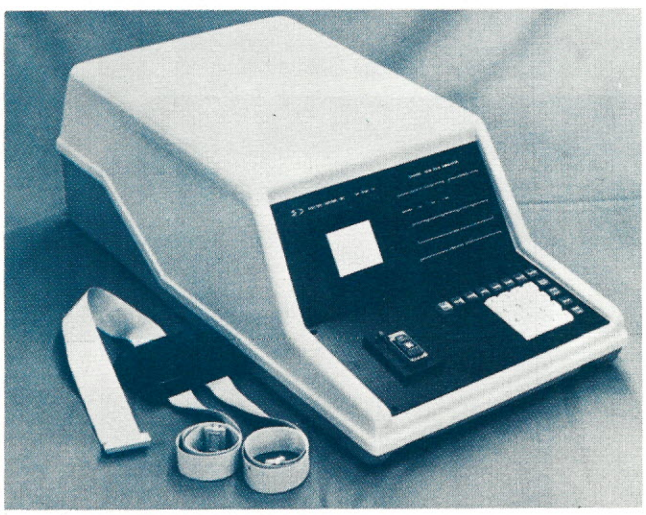
The Printerm Model 879 is a high-speed bidirectional micro/mini printer, 120 cps at 75 lines per minute, 9×7 or 9×9 high density matrix, with up to four copies. It features a 96-character ASCII character set (uppercase, lowercase and triple wide expanded), operator switch selectable 80- or 132-column format and RS-232 and parallel interface.

Simple in design, it uses only three sub-system moving parts for high reliability; all servo motors are directly driven. It contains 2K memory for full page CRT dump and uses roll paper feed, combination pin form and roll feed or tractor feed. Price is $1395.

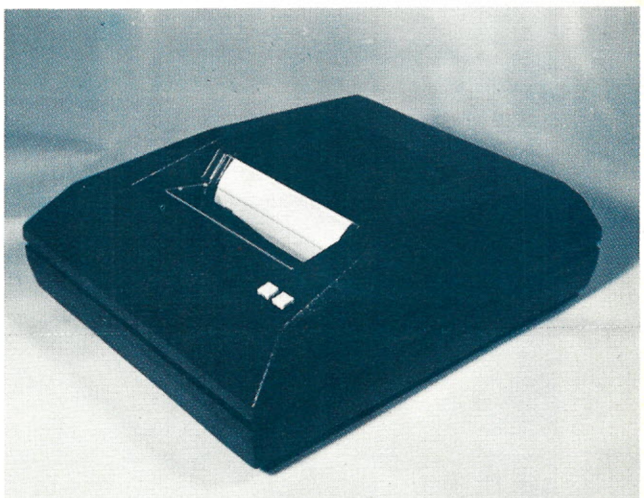
Printer Terminals Corp., PO Box 535, Ramona CA 92065.

M6800 Development System

The EXORterm 220 display terminal and console is designed for software and hardware sys-



The ED-6000.



The Model 879.

EXORterm 220.

tem development for all Motorola and second-source M6800 family microprocessors and single-chip microcomputers operating at speeds up to 2.0 MHz. EXORterm 220 facilitates the exchange of data between the user and the system via a high-quality video interface in conjunction with a keyboard. To further enhance the efficiency of the interface, special keys have been encoded to invoke functions unique to the development system in each of its command levels—EXbug and DOS.

EXORterm 220 incorporates a CRT chassis with a keyboard and isolated motherboard, MPU II module, DEbug II module, two 16K RAM modules, the resident relocatable macro assembler/linking loader and the CRT editor, which allows the user to create and modify source programs.

The assembler, in translating assembly-language programs into a relocatable object file, provides the relocation and linking of modules and macros, plus conditional assembly; the linking loader converts the relocatable object file into absolute object codes. You can also use the terminal as an asynchronous editing terminal through connection to a host computer (or other external device) via the serial interface (RS-232C or current loop), essentially bypassing the isolated motherboard. EXORterm costs $8600; the system with static RAM costs $9200.

Motorola Microsystems, PO Box 20912, Phoenix AZ 85036.

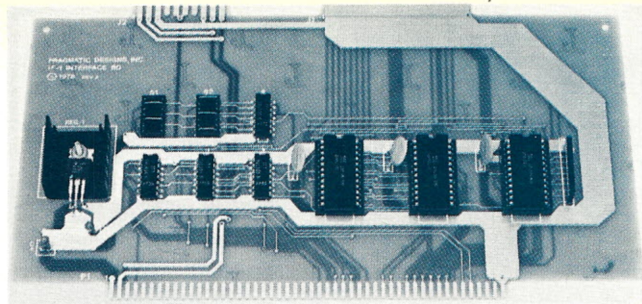
PET Floppy Disk/S-100 Adapter

The EXS-100 provides a combination floppy disk controller and S-100 adapter for the PET computer. It connects to the PET memory expansion socket with a flat cable. The single S-100 board can be plugged into any S-100 mainframe for expansion to the S-100 bus. Up to three minifloppy disk drives plug directly into the EXS-100, giving the PET high-speed disk storage.

As a floppy disk controller, the EXS-100 uses the standard IBM 3740 format and will drive up to three minifloppy disk drives for up to 240K of storage. A special software package that allows you to load and store programs from the disk is available. The EXS-100 board also has provision for EPROM storage on-board, so that the disk software will always be instantly available.

As an S-100 adapter, the EXS-100 is full-buffered and generates the full complement control lines. The EXS-100 assembled as an S-100 adapter only is $199.95; EXS-100 assembled as a disk controller only is $299.95; EXS-100 assembled as a combination S-100 adapter and disk controller is $349.95. The board is also available in a complete disk package for $799.95.

CGRS Microtech, PO Box 368, Southampton PA 18966.



The IF-1.

IF-1 Interface Board

The IF-1 I/O card interfaces the ICTM-1 integrated circuit tester module to S-100 bus computers. While primarily intended as a dedicated interface, IF-1 can also be used as a general-purpose I/O card in applications that require up to 16 output lines and eight input lines.

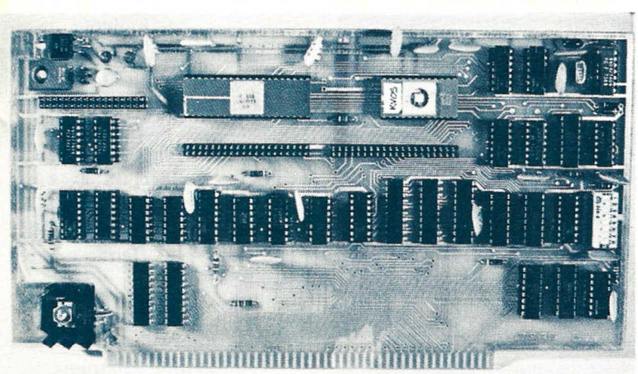
IF-1 provides two fully buffered 8-bit output ports and one fully buffered 8-bit input port. I/O address decoding is jumper selectable on any four port boundary in the system I/O address space. All 24 I/O lines are brought out to a single 50-pin mass terminated cable connector. All signal lines are separated by ground lines to minimize problems caused by noise and crosstalk. A separate 10-pin connector supplies a regulated +5 V and the unregulated +8 V, +16 V and −16 V S-100 power supply lines. IF-1 is $89.95, kit, and $119.95, assembled and tested.

Pragmatic Designs, Inc., 711 Stierlin Road, Mt. View CA 94043.

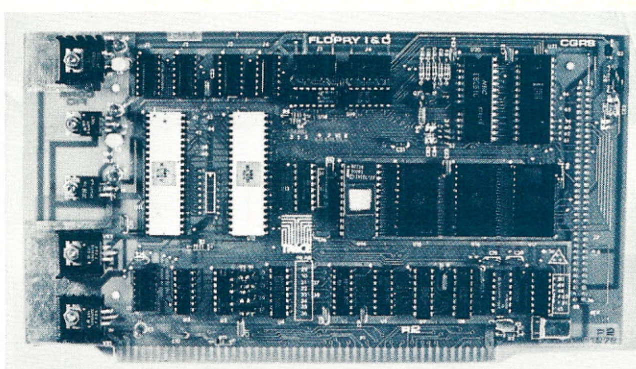
Floppy I/O

Trace Electronics' single I/O card for the S-100 bus contains: four programmable parallel ports, two duplex serial ports, a baud rate generator, two 16-bit programmable interval timers, room for up to 16K of EPROM (2708, 2716, 2732) and a connector to adapt the Persci 1070 intelligent floppy disk controller to the S-100 bus.

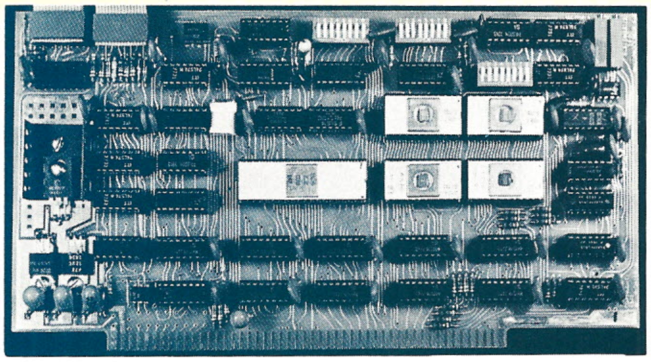
This single card can interface CRT terminals, keyboards, printers, paper tape readers, EPROM programmers, up to four floppy disk drives (with controller) and still provide EPROM space and two 16-bit timers. The "floppy I/O" card is compatible with Altair 8800, Imsai 8080 and the



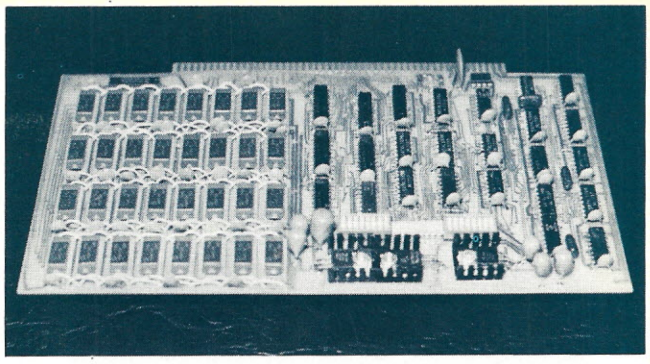
The CGRS EXS-100.



TE's S-100 I/O card.



The Slavemaster 2650.



Microcosm's 64K RAM board.

CGRS 6502/S-100 MPU. It is available in kit form ($169.95) and assembled ($219.95).

Trace Electronics, Inc., 570 W. DeKalb Pike, King of Prussia PA 19406.

Slavemaster Multiprocessor

The Slavemaster 2650 is the first S-100 bus multiprocessor system that fully utilizes all available bus time by allowing two microprocessors to operate with fetch/execute cycles interleaved. Precise single processor timing is maintained, and, once synchronized, there is no interaction between the two processors. This system is implemented with two Signetics 2650 microprocessors: Slave and Master; the Master has the ability to stop, reset or jump the Slave.

The Master can be used as a dynamic debugging tool; it may change and monitor any of the Slave's S-100 resources while remaining fully transparent. Real-time control, parallel processing, foreground/background and front end pre-processing are other possible applications.

The interrupt driven real-time functions, keyboard processing, timekeeping, power fail detection and eight possible external priority interrupts are especially useful while doing multi-task operations.

Victoria Micro Digital, 401 Dundee St., Victoria TX 77901.

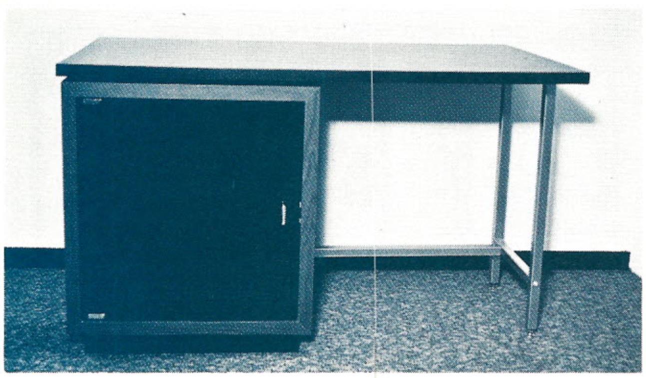
Desk and CPU Cabinet

Make your computer system feel at home with a new desk and CPU cabinet from Group Two, 4901 Morena Blvd., Suite 305, San Diego CA 92117. The work station desk top area measures 24×48 or 32×60 inches; 26-inch chrome legs with a cross brace and adjustable levelers attach to the cabinet.

The cabinet features a bronze Plexiglas door with chrome hardware and a magnetic lock, a removable back panel and a 19-inch rack—21 inch high front and four rear metal mounting rails. Adjustable shelves are optional. The price of the unit is $290.

Business Applications Source Listings

Source listings and programming language and users manuals for CPA (Computer Prepared Accounting), a general ledger system, and Write-On, an automatic letter writing system, are now available from Micro Store, 634 S. Central Expressway, Richardson TX 75080. The BASIC language source listings include code segments of utilities and routines that users can patch into other programs.



Group Two work station.

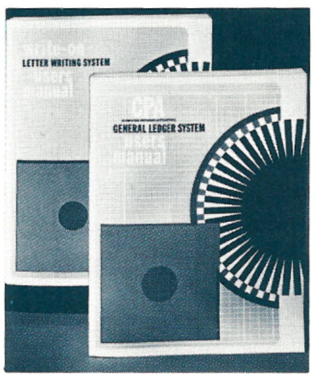
CPA consists of 2000 lines of code, including ISAM (indexed sequential access method), a sort segment and routines for chaining trailers—used to mark an audit trail—both forward and backward. The system accommodates up to 200 accounts and issues comments and prompts to guide you at crucial entry steps.

Write-on contains 700 lines, including segments of string manipulation coding that illustrate the use of string operators and functions.

Both listings work with an ICOM company model FD3712 dual-drive floppy disk storage device and a Diablo or dot-matrix printer. You must adapt the software to systems with other components; at least 32K bytes of RAM are required. Listings, complete with manuals, of the two systems sell for $75 each.

64K RAM Card

A recently developed 64K RAM card from Microcosm, Inc., 534 W. 9460 S., Sandy UT 84070, reduces your system card count by using only one S-100 card slot. It uses only as much power as the standard 16K RAM card, thus lowering power requirements.



Micro Store's business programs.

Buffered signal lines mean less loading on buses. Memory is expandable in 16K byte increments up to 64K bytes, and memory may be disabled in 256 byte blocks for ROM programs. The fast cycle time of the new 16×1 dynamic RAM requires no wait states for reads, writes or refreshing. Memory card handles refresh.

Property Management Program

REAP (Realty Analysis Expense Program) provides complete expense information for each building in payment-by-payment and summary format, including tax-ready totals for IRS filing.

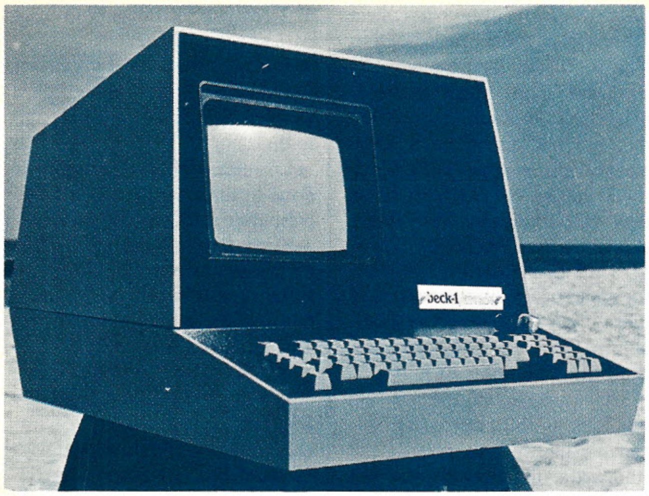
The Building-Payee report displays expenses for any building, for all or selected payees. A year's payment record, including total yearly expense, average monthly expense and total number of payments, can be displayed on screen at once for any regular paid account.

The Utility-Summary report displays yearly, year-to-date or monthly average utility expenses for each building under the categories—electric, gas, water, trash. The Tax-Totals report displays totals for each building under utilities, insurance, repairs and property tax. Special accounts can easily be set up to track other expense types. REAP is available on cassette with complete documentation for the TRS-80 Level I and II, Apple and PET for $25.

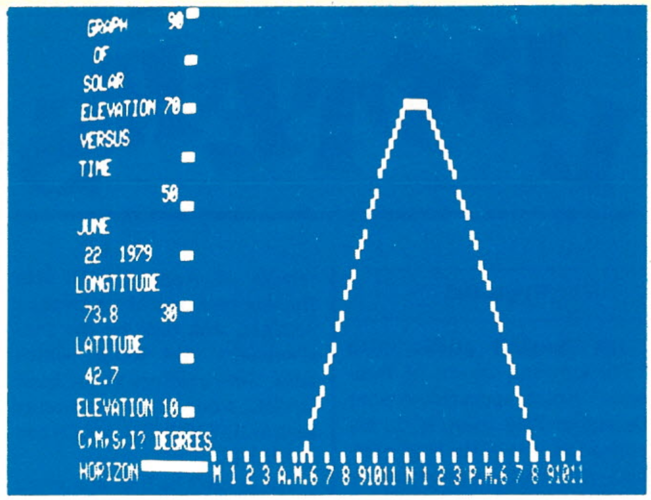
Realty Software Co., 2045 Manhattan Ave., Hermosa Beach CA 90254.

Accounting Programs

The Accounts Receivable 201



Beck's arcade computer.



Display from Sungraph program.

and Accounts Payable 301 program packages from Data Train, Inc., 840 NW 6th St., Suite 3, Grants Pass OR 97526, operate on Wang "T" and PCS II models with mini, floppy and hard disk storage devices. Selection of storage devices is under user control.

The A/R 201 features balance forward and open item modes of handling receivables, on-line invoicing for low-volume invoicing needs and a repetitive billing option, in addition to all the necessary accounting reports and audit trail.

The 301 business package performs the necessary accounting and audit trail reports and also provides the following features: a purchase summary report by job number, a cash requirements report based on due date, override control on payments and check printing.

Both programs will integrate to DTI's General Ledger 101 under user control and require 8K to 16K memory and dual mini or floppy disk drives or hard disk with a single floppy available. The 201 costs $900; the 301 is $600.

Sungraph Program

Now you can keep close tabs on the position of the sun with the Sungraph program from Solartek, PO Box 298, Guilderland NY 12084. The program calculates and graphs the position of the sun; the sun's local elevation and azimuth can be calculated at any location on earth.

Options include graphs of elevation vs time of day, azimuth vs time of day, maximum elevation vs date and elevation at a specified azimuth vs date. The save option allows you to store a graph on cassette and reload it at a later time. Written in TRS-80 Level II BASIC, the program requires 13K bytes of storage. It is available on cassette for $49 or diskette for $75.

The Beck-1/Arcade

The Beck-1/Arcade combines the computer and TV input processor, operators monitor and keyboard into one compact, portable package to provide a high-performance computer photography and arcade system. In addition to photography applications, the Beck-1/Arcade is a sophisticated biorhythm computer, performing the complex calculations and plotting the three biorhythm curves along with an assessment of the day's situation.

The portrait system contains two memories: one for the printer and one for the monitor so the operator can be composing the next picture while the previous one is still printing. The operator can adjust the contrast and brightness for each subject and "freeze" the picture any number of times until he captures the perfect expression . . . all before printing. Picture size is adjustable.

The Beck-1/Arcade comes as a component unit priced at $3700 for upgrading or integration with a printer and video package. Alternatively, a complete arcade system, consisting of the arcade computer, a Centronics 102 printer, TV camera and zoom lens and a 19-inch audience monitor, is $11,500. The biorhythm option is $1000 on either package.

Beck Corporation, 303 Slocum Ave., Neptune NJ 07753.

KB CALENDAR

San Francisco CA

The fourth annual West Coast Computer Faire will be held in San Francisco's Civic Auditorium during May 11-13, 1979.

The Faire is primarily concerned with inexpensive computing for home, business and industry. Conferences covering topics in these areas are scheduled.

Arlington VA

A symposium on "Microcomputers in Education and Training" will be held in Arlington VA, May 17-18, 1979. For information, write to Society for Applied Learning and Technology, 50 Culpeper Street, Warrentown VA 22186, or call (703) 347-0055.

Pasadena CA

Infotech International, Inc., is presenting spring/summer state-of-the-art conferences and tutorials, which will be held in March, April, May and June in San Francisco, Washington DC and Chicago.

For more information, write to Infotech International, Inc., 234 E. Colorado Boulevard, Pasadena CA 91101, or call (213) 793-0687.

CORRECTIONS

The January 1979 PET-pourri listed the old address of the Excel Company in El Cerrito CA. To ensure that all correspondence reaches the company, Excel has asked us to list its new address: PO Box 1147, El Cerrito CA 94530.

LETTERS

Wright On!

Jim Wright's article titled "The Ups and Downs of Business," which appeared in your December 1978 issue, is, in my estimation, one of the most practical small-business programs for a microcomputer that I have seen. I have converted it to Level II BASIC and, for the first time, am able to get a picture of sales and cost trends in my business.

By using a Polaroid camera with a close-up lens I am able to pictorially show my salesmen a graph of their sales for the past 10 years. In addition, I like the ability to save data on tape with this program. Kudos to Mr. Wright.

H. J. Somermeyer
Nebraska City NB

This is the program I have been using for demonstrating the power of microcomputers to businessmen's groups. I show them a graph of the sales for 73 Magazine *for the last five years—then the smoothed average of the sales—and finally the change in sales. It's most impressive. I carry along data tapes with the figures for pages of advertising, sales of books, and other sales details that businessmen can identify with. A similar program for the Apple, with different colored graphs for comparing two or more functions, would be handy—if that gives anyone ideas for programming—Wayne.*

Apple Polisher

If your motive for publishing Robert Richardson's unprovoked blast at the Apple II (February 1979, p. 20) was to generate more letters, you've succeeded. At first I wondered if the article he refers to, Bob Bishop's review of the Apple II in the November 1978 *Kilobaud*, might not have left out some important features. The only criticism I can make is that Bob makes too much of the lack of high-resolution routines in the BASIC ROM and in the first version of the floating-point BASIC. Of course, both problems have since been solved, first by the release of Applesoft II with floating-point *and* hi-res graphics routines, and then by the Programmer's Aid ROM, which adds hi-res routines to the basic BASIC, along with some niceties such as BASIC RENUMBER and APPEND.

No, it can't be Bishop's article that's at fault, so I suspect it may be Mr. Richardson. Otherwise, why would he state flatly that the Apple II is "bereft of features that are offered by . . . TRS-80?" Come, come, Mr. Richardson. Granted you have to pay a premium for Apple; surely you don't claim that the TRS-80 has full-color graphics? Or 200-line-resolution graphics? How about a built-in speaker under program control? Built-in A/D interface? Built-in assembler and disassembler? 1500-baud cassette interface that doesn't require disconnection in order to permit rewinding and fast-forward? RAM expansion up to 48K bytes without buying an additional chassis?

Come to think of it, nobody in his right mind would make such a blatantly and egregiously wrong statement. I submit that "Robert M. Richardson" is just a pseudonym for Wayne Green, who states on the very next page that his work on Apple programs reveals "spectacular improvement" when color is used. It must be too quiet in Peterborough. . . .

Allen Watson III
Redwood City CA

This is in answer to the letter from Mr. Richardson in the February 1979 issue criticizing "The Remarkable Apple II" by Bob Bishop. In one respect I must agree with Mr. Richardson: the article was somewhat dry and uninspiring.

What I *cannot* agree with is Mr. Richardson's opinion of the Apple II. Those who read the letter from me in the September 1978 issue (p. 17) noticed that I came back to the U.S. from two years in the Philippines all fired up to buy a TRS-80. I am proud to say I am an Apple II owner. The things that changed my mind involved talking to some Radio Shack managers who freely admitted they knew nothing about the TRS-80 except how to collect money from those who wished to buy it. There was no support available from your friendly, neighborhood Radio Shack. One manager told me he had suggested that all managers be given a short course on the TRS-80 so they could be more knowledgeable. The idea was turned down. Why should I spend my kilobucks for a microcomputer system when there is no local expertise available to help me with any questions that may come up?

This leads me to the Apple II. I was looking for a micro that was capable of not only playing the standard games and keeping records, but one that also had a fine graphics capability.

I stumbled across the Microcomputer Shoppe in nearby Corpus Christi and the father-and-son team of Lyle and Kevin Persels. Lyle is a salesman who knows his product and how to sell it. He also knows the competitors and can intelligently compare them. Kevin is a highly talented programmer who can communicate on any level from rank novice (me) to expert. They and their staff can also service what they sell. Those are the main reasons I didn't buy the TRS-80, with apologies to Ed Juge, but went with the Apple II instead.

There isn't a microcomputer that is right for everyone. Some people are satisfied with a KIM-1, and others will never be satisfied. Wayne summed it a long time ago in one of his columns: determine *your* needs, find the best compromise among what is available *now* and buy it. If you keep waiting for what is going to be available next year, you'll be cheating yourself out of a lot of fun and experience . . . and maybe even money from an article or Instant Software. Join the parade; stop sitting on the sidelines tapping your foot.

Dan Lane
Kingsville TX

It's not apparent from Mr. Richardson's letter which features he found "bereft" in the Apple II. His short comment was open-ended with no specifics.

As an Apple II owner and user, I comment that perhaps the specific features Mr. Richardson needed were not part of Apple's intended design. I am biased toward the system I have, but let me list as many things about the Apple as I can to provide a basis for comparison.

First, what I find that Apple doesn't have:

- A built-in video monitor—I use a Sanyo, bought separately.
- A cassette recorder, built-in or part of the package.
- Named files with the cassette SAVE command. (This wasn't a problem for me—I intended to go to disk.)
- Lowercase characters—can be done in software or with a hardware change. A bit messy though.
- More than 40-column output format—makes it difficult to do wider formatting unless you output directly to hard copy.
- A numerical keypad (?).
- Pre-formatted graphics characters in ROM—not one of my needs.
- PRINT-USING command with extended BASIC—software routines are possible though awkward.

Next, those things that I find Apple does have (conceding that most any system will have a high-level language and so on):

- Documentation—Apple II system documentation includes *all* connector pin-out designations, complete schematics, source listings of the monitor and utility programs, including sweet 16, a 16-bit interpreter, and the Apple mini-assembler. Two great programming manuals are available, one for each type of BASIC, and each accessory has its own complete manual.
- Expansion—memory is expanded just by plugging the chips into the sockets already provided. Eight accessory expansion sockets are already installed, too. No expansion chassis and extra power supplies are needed. Power is supplied by the built-in switching power supply. This supply will run all the properly designed accessories plugged into the expansion sockets, including the disk-drive controllers.
- Accessories—just plug them in and go. No software to load to run them either; it's all in ROM. And many accessories are available from other sources (besides Apple) because of the expansion ease built into the Apple II.
- Prototyping—Apple supplies full documentation of their bus. All required signal levels, loading of circuits and specifications for connecting your own stuff are provided. A prototyping card, designed for the Apple bus, is part of the prototyping package.
- Easy I/O—a 16-pin connector provides programmable access to four latchable output bits, three input bits (switch sensing) and four analog-to-digital converters (one port each). This socket is intended for use with such things as game paddles, but there are many other possible uses. Simple interfacing to a printer or Teletype is possible through this connector.

- Mini-assembler—Apple's built-in mini-assembler makes assembly-language programming possible directly from the keyboard. Labels and named operands are not allowed, but the assembler is there, in ROM, any time you want to use it.
- ROM sockets—two ROM sockets are available for users to include their own programs in permanent storage.
- Sound—a built-in speaker provides a transducer for music synthesis, game responses and speech recognition.
- Color graphics (LORES)—16 colors to provide animated graphics in a 40×40 block matrix. Screen writing speed is fast enough to allow paddle- and ball-type games and many other high-speed interactive displays.
- HIRES color graphics—color dots in a 280×192 matrix for animated graphics. Programming commands and shape tables allow HIRES graphics in *any* shape. Text can be interactive with graphics.

All the low-cost personal computers are excellent choices for beginners and game players (and those interested in nontechnical applications). But, serious engineers/programmers should start with something more substantial and reliable. The Apple II has the required qualifications.

Chuck Carpenter
Carrollton TX

Super Software

I'd like to pass along a positive experience I had with a software dealer, Supersoft of Champaign, Illinois. I have a SOL/20 with North Star disk and have ordered several programs on disk from Supersoft, ranging from games to text editors. I can report that they are all excellently prepared and tested.

More important, however, was the willingness of Herbert Schildt to help me with a problem that arose. It turned out to have nothing to do with the software.

I recommend this company most highly to all North Star users.

M. Blair Sibley
Albany NY

REPROM

Enclosed is a completely revised version of my PROM program for the KIM (September 1978, p. 103). It uses the KIM pointers 17F5-17F8 to contain the addresses for the PROM data and runs like the KIM cassette routines. Load the starting addresses into 17F5-17F6 and the end address into 17F7-17F8. Then go to 0000 and hit GO.

The PEEK routine has also been revised so that it initializes the programmer before displaying the data. Go to 0099 and hit GO. The contents of the first data byte in the PROM will be displayed. To increment the address of the PROM, hit STOP and the next data byte will appear.

If the VERIFY and PEEK routines do not run properly because the programmer jumps addresses, the problem may be in the connection between PB-0 and the 7404. This can be helped by putting a .001 uF capacitor from PB-0 to ground.

If anyone wants a copy of the revised program, I will copy it onto a cassette tape for him. Just send me a good cassette with an SASE and I'll make a copy. If you can, include a program of your own in exchange.

Jim Grina
1284 Fifield Pl.
St. Paul MN 55108

```
0000   JSR PROM              20 06 00
0003   JMP KIM               4C 4F 1C
0006   LDA #64     PROM      A9 64
0008   STA CYCLE             85 EE
000A   LDA #AD               A9 AD
000C   STA VEB               8D EC 17
000F   LDA #FF               A9 FF
0011   STA DRB               8D 02 17
0014   STA DDRA              8D 01 17
0017   LDA #0F               A9 0F
0019   STA DDRB              8D 03 17
001C   JSR INTVEB  A1        20 32 19
001F   LDA #05               A9 05
0021   STA DRB               8D 02 17
0024   JSR VEB     A2        20 EC 17
0027   JSR PRGM              20 74 00
002A   LDA #10               A9 10
002C   BIT DRB               2C 02 17
002F   BNE A5                D0 11
0031   JSR INCA              20 89 00
0034   BCC A2                90 EE
0036   LDA #FF     A4        A9 FF
0038   JSR PRGM              20 74 00
003B   LDA #10               A9 10
003D   BIT DRB               2C 02 17
0040   BEQ A4                F0 F6
0042   DEC EE      A5        C6 EE
0044   BNE A1                D0 D6
0046   LDA #00     VRFY      A9 00
0048   STA DDRA              8D 01 17
004B   LDA #0D               A9 0D
004D   STA DRB               8D 02 17
0050   JSR INTVEB            20 32 19
0053   JSR VEB     V1        20 EC 17
0056   CMP DRA               CD 00 17
0059   BNE B2                D0 0E
005B   LDA #0F               A9 0F
005D   STA DRB               8D 02 17
0060   DEC DRB               CE 02 17
0063   JSR INCA              20 89 00
0066   BCC V1                90 EB
0068   RTS                   60
0069   LDA VEB+1   B2        AD ED 17
006C   STA KPL               85 FA
006E   LDA VEB+2             AD EE 17
0071   STA KPH               85 FB
0073   RTS                   60
0074   STA DRA     PRGM      8D 00 17
0077   CLD                   D8
0078   NOP                   EA
0079   LDA #03               A9 03
007B   STA DRB               8D 02 17
007E   LDX #C4               A2 C4
0080   DEX         C1        CA
0081   BNE C1                D0 FD
0083   LDA #06               A9 06
0085   STA DRB               8D 02 17
0088   RTS                   60
0089   JSR INCVEB  INCA      20 EA 19
008C   LDA VEB+1             AD ED 17
008F   CMP EAL               CD F7 17
0092   LDA VEB+2             AD EE 17
0095   SBC EAH               ED F8 17
0098   RTS                   60
0099   LDA #00     PEEK      A9 00
009B   STA DDRA              8D 01 17
009E   STA KPL               85 FA
00A0   STA IRQH              8D FB 17
00A3   LDA #17               A9 17
00A5   STA KPH               85 FB
00A7   LDA #B9               A9 B9
00A9   STA IRQL              8D FA 17
00AC   LDA #0F               A9 0F
00AE   STA DDRB              8D 03 17
00B1   LDA #0D               A9 0D
00B3   STA DRB               8D 02 17
00B6   JMP KIM               4C 4F 1C
00B9   LDA #0F     P1        A9 0F
00BB   STA DRB               8D 02 17
00BE   DEC DRB               CE 02 17
00C1   JMP KIM               4C 4F 1C
```

Revised PROM program.

Do Small Businesses Really Need Micros?

I keep reading about the "unexplored or undeveloped markets" for microcomputers in small business.

Mr. Soderberg's letter in the January 1979 issue (p. 19) speaks of the very small businessman, who "may still even carry his receipts and paperwork to his accountant in a shoe box," and then adds the monstrous argument of "inventory control, lost orders, overstocks, out of stocks and organization problems."

Why do I say monstrous? Let's look at what a small business *is* according to the Congressional report "Future of Small Business in America."

In 1971 there were 12.4 million business enterprises in America, including 3.3 million farms. 6.4 million grossed less than $10,000; 3.4 million grossed between $10-50,000; 1.0 million grossed between $50-100,000. (To get 1978 dollars, multiply by 1.6.)

Hence, only 1.6 million businesses grossed over $100,000 per year, and those are the microcomputer candidates (less the really big business). Even though the data came from 1971, the situation is no better today.

In 1969, 548 businesses "went public." By 1977, only 29 businesses could make it "public."

The number of small businesses has increased by virtue of national growth, but the galloping trends toward economic concentration and increased acquisitions and mergers means that more small businesses are sharing a decreased piece of the economic pie.

The automatic question is: "How do these people live on that money?"

They don't. They work for somebody else. Many small businesses are operated as tax gimmicks. In today's economy, any business grossing less than $35,000 has to be a sideline. Con-

gressional statistics indicate that there may be more enthusiasts than business candidates for microcomputers.

Mr. Soderberg states, "Enthusiasts probably only exist in the hundreds of thousands . . . dwarfed by millions of very small businesses that *should* be the real marketplace."

Until the government quits playing with the rules, the accountant is indispensable to the small business. The tax code is massive and, like all rules made by lawyers, subject to interpretation. An IRS agent will *force his* interpretation on the uninitiated, but a qualified accountant can defend a position. And if the accountant errs, *he* pays any fines levied.

Most small businesses do their own books and let the accountant handle the fiscal end.

Reliability is going to be a question mark for the few small businesses that can profit from a microcomputer. And a small businessman doesn't or shouldn't purchase a $3-4000 micro to save a couple of hundred a year—he thinks it should earn a couple of hundred because it cannot replace people. It can only do some of the work of one overworked person.

The one sure way to make money with computers is to be a small businessman and sell 'em.

Lee Grow
Palm Beach Gardens FL

Considering that NEBS, right here in Peterborough, is selling bookkeeping systems and forms to well over one million small businesses, there must be some question raised about the government statistics. But look at it from the point of view of the businessman. He can buy a $5000 microcomputing system, complete with software, which will do his accounting and print it out for checking by his tax accountant, thus saving much time (money). The cost of this would run $125 a month on a five-year basis, about one-fifth the cost of a clerk to sit and do the bookkeeping work. And this system will not only have all of the management information immediately at hand, it will sit there and type out invoices, statements, checks to pay bills, etc., all at the $125-a-month salary rate. I think the market is almost unlimited for such systems.

The $4000 cost of a microcomputer and some programs would net out to about $100 per month on a five-year amortization basis. That's so much less than the cost of an extra clerk to do the busywork that it has *to be economically effective.*

In the few places I've seen microcomputers used around Peterborough (fuel-oil distributors), I've seen the principals of the firms able to get a good hold on their business for the first time. No longer do they have to wait for a service bureau to input data, process it and then send copies of the printout back so the firm can see how they are doing, answer questions from customers, etc. They are able to input data in a few minutes and have it on hand immediately from then on. The system prints invoices, statements, payroll, etc. It helps them set fuel prices, keep track of inventory and even route the delivery trucks.

What real estate dealer will be able to function without a computer to keep track of properties and match them to customers? And the computer, with some word-processing capability, can crank out legal forms for sales and contracts. If we have at least a dozen real estate dealers of significance in this area, how many are there in the country?

If we had a good real estate program to see I know we could sell at least 20,000 of them; the hardware involved would sell just as fast. Someone is going to make millions on sales like this—if we get the programs.

The same goes for most professions. I don't know if dentists qualify as small businessmen or not, but I do know there are an awful lot of dentists, and they are prime candidates for a small-computer system that will allow them to dispense with a service bureau and get the information in house.—Wayne.

Simple Conversion

In case no one has taken the trouble to convert Rod Hallen's "Simpler Interest" so it can run on the TRS-80, the conversion is shown in Fig. 1.

By adding lines 255 and 256 you will have to eliminate line 220, which will not work in the TRS-80 anyway.

In lines 130, 150, 170 and 190, eliminate the question mark and replace the comma with a semicolon.

This is a very useful short program, the likes of which I would enjoy seeing more of.

I look forward each month to your magazine and to more business programs and fewer "games," which are of no interest to me on a $4000-plus investment.

George R. Bullitt
Haddam CT

```
210 CLS:PRINT"MONTH";TAB(14)"PAYMENT";TAB(25)"PRINCIPAL";
215 PRINT TAB(39)"INTEREST";TAB(52)"NEW BALANCE"
255 X=X+.005
256 X=INT(X*100)/100
300 PRINT M;TAB(14)P;TAB(25)Y;TAB(39)X;TAB(53)B
```

Fig. 1.

Very Kind

I applaud your magazine. You maintain a perfect hardware/software mix. You also haven't forgotten relative newcomers like me to personal computing.

I read with great interest Tom Pittman's "Dots" (February 1979, p. 84) and was surprised, but delighted, to read his praise of the RCA 1802. Perhaps now this sleeping giant will be awakened.

When will others besides *Kilobaud MICROCOMPUTING* start to take the 1802 seriously? There must be thousands, like myself, with home-brews and Elfs waiting for really good expansion modules for the 1802 to come out.

Many thanks for past performance on the 1802, and keep up the great work.

Dale Kind
Hudson MA

What Gives?

How did Mr. Fehringer make out with his home-brew service bureau (December 1978, p. 30)? Since his story was written in March 1977, enough time has elapsed (obviously) to tell if he succeeded or flopped. Please ask Mr. Fehringer to follow up his story. The suspense is killing.

William R. Hamblen
Nashville TN

Regarding Mr. Hamblen's inquiry about my home-brew service bureau: It never came to pass for a variety of reasons, but primarily because as soon as I approached the grain elevator, the service they had been using felt the competition and drastically reduced prices.

Initially, the elevator had been very interested, and I had done the flowcharts and some of the coding before the price went down.

At the present time, Farmland Industries, the co-op from which the elevator co-op buys most of its supplies, has set a timetable for all its members to switch to their computer. Each member will have a terminal connected directly to the central computer in headquarters. The reason is essentially to provide electronic mail. I have been told that it costs them more than one-million dollars for mailgrams and more than seven-million dollars to mail price lists each year. An in-house terminal for each member will provide up-to-the-minute prices as well as many other advantages.

I am working on a couple of other things, and if they pan out, I hope to write an article about them.

B. G Fehringer
Sidney NB

On the Horizon

I just wanted to let your readers know of my favorable experience with North Star Computers, Inc. I have been impressed with the quality of the hardware and technical support supplied with the Horizon computers.

I ordered a Horizon I computer in kit form in June 1978. When I received the computer three weeks later, I was surprised to find the quality of the parts so high and assembly so easy. Upon finishing the kit, it did not pass preliminary tests, so I troubleshot it and returned a part that I thought was defective. This part was returned to me within three weeks with a note explaining that it worked fine. It was recommended that I return all of the boards before the 90-day warranty expired. I mailed my boards off and got them back in less than a month . . . repaired at no charge. A delay line had been bad.

The total cost of mailing was less than $10, and the response from North Star was beyond expectations. I recommend a Horizon to anyone who wants a microcomputer with large computer quality.

Christopher W. Carlson
Las Vegas NV

COMPUTER CLINIC

As a new subscriber to *Kilobaud MICROCOMPUTING*, I want to tap your brains.

Originally, I had an Imsai 8080, a Hazeltine Mod 1 CRT, 32K of memory, a Tarbell cassette-interface board and a professional tape recorder. I was operating with an Imsai 8K BASIC interpreter. Since that time I have added a Micromation dual floppy 8 inch disk setup with interface and now have an Anderson/Jacobson Selectric printer. I am running on BASIC-E and C-BASIC and the CP/M system.

From your magazine and others, I note that many BASIC programs are available on cassettes. I can load cassettes in and operate on CP/M, but how do I load in a cassette BASIC program and transfer it over into the floppy disks under the CP/M?

I can use my CP/M editing system for necessary modifications, but I first must get the program from the cassette into the floppy disk.

Any suggestions?

George Burns
PO Box 19144
Indianapolis IN 46219

I have an S-100-based computer system and wish to expand the motherboard beyond its 20 positions. I have not been able to locate any source of information on connecting/interfacing my present motherboard to another motherboard, or is this practice impractical?

Charles T. Huth
146 Schonhardt St.
Tiffin OH 44883

I enjoy *Kilobaud MICROCOMPUTING* and wait impatiently each month to see what programs or ideas I can get to try on my computer. I have a TRS-80, Level II, 16K that I use in my retail appliance business. My major project at the moment is putting our 2500 accounts on the computer, and I could use a little help.

When the Level II is loaded with data, any change in the program causes all of the data to be lost. Is there something I can POKE to eliminate this clearing process?

W. C. Sharpe, President
Sharpe's Appliance Store, Inc.
457 Moreland Ave., NE
Atlanta GA 30307

I've just recently purchased a Heath Microprocessor Trainer, model ET-3400. It went together easily and the training course is a really great way to learn about MPUs and minis. One problem I've encountered is in interfacing. A 40-pin strip is provided for I/O, but I can't find the necessary connectors anywhere. Heath recommends an AMP #2-87215-0 and 2-87543-0 to do the job, but I can't turn one up. Can somebody please put me on the right track? Visions of wiring up my darkroom and whole apartment are dancing in my head, and I'm stymied!

Bill Chase
8600 Theta #85
Houston TX 77034

For a long time I have been an interested reader of your magazine.

Today I want to address the following problem. To coordinate software development, I have begun to erect a software-information bank in Germany. In this bank, information about finished programs will be collected, and people who are interested will get free information about the existing programs. Because of better software development by American computer users, your readers create interesting programs in which German users are interested too.

For that reason, I would be very glad if you could report about my software-information bank in order that your readers and my information service could exchange information (using descriptions, flowcharts and listings). I would be glad to hear about similar institutions in the USA.

Norbert Kreft
Postfach 1745
D-7630 Lahr
West Germany

I would be grateful for any information concerning a minicomputer board named "FLIP CHIP®." It has an 8008-1R CPU and appears to have on-board RTTY capability. The bottom connectors are four groups of 18 contacts each per board side. At the top is a 50-pin male socket and crystal.

C. Ramsey
RD 2, Box 334
Harpursville NY 13787

BOOKS

(from page 12)

include scientific dilemmas, translating ancient writings and transmissions, handling damage control due to space "storms," resolving systems and personnel conflicts—these are all one level higher than simply blasting Klingons to space debris. Perhaps our hardware limitations provide only the lowest level of challenge, much as my cat finds it challenging to ambush a ball of yarn but doesn't find it challenging (since she doesn't have the capability) to solve a differential equation.

The typos are remarkably few. On page 110 under "Hardware," the word consider should have been consideration. Also, the author confuses a few scientific terms. On page 1 he confuses mass with weight; and in the navigation sub-module excerpted above, he confuses velocity with speed. Finally, two comments:

1. An author, when presenting a project of this size, has the responsibility to verify that the project can be done. As such, the project should have been coded up—in any language—as proof of concept. The reader knows well that there is a big difference between describing a large, interactive program and actually making it work. He would like to be assured that someone else had successfully completed the project.

2. The ambitiousness of this project apparently exceeds the hardware limitation of most small home/hobby computers. A 4K Radio Shack TRS-80 is just not up to the task. I would guess that a 32K Apple II with a disk would be the class of machine necessary. Be forewarned.

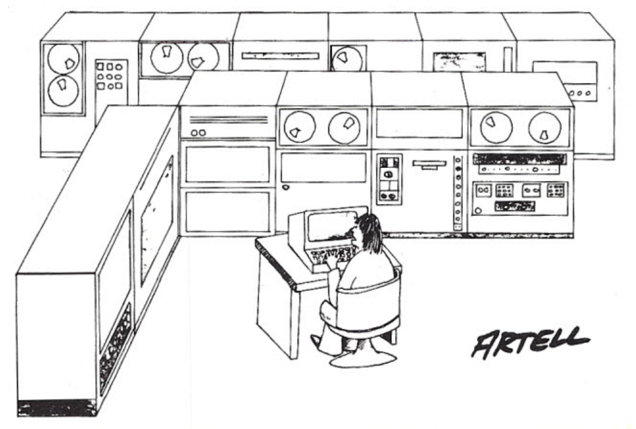
In the final analysis, however, my hat is off to Roger Garrett for a job well done and an important contribution to the field.

John Martellaro
New Mexico State University

New Releases

The Phase-Locked Loop Reference Book with Experiments, Howard M. Berlin, 275 pp., $8.95, E & L Instruments, Derby CT. Covers nonmathematical principles of the phase-locked loop.

Bugbook VIII, 8080/8085 Software Design with 190 Software Solutions, Dr. Christopher A. Titus, 288 pp., $9, E & L Instruments, Derby CT. Detailed treatment of assembly-language programming for 8080- and 8085-based computers.



"Let's see—Bob had the BLT; that's $1.60. Tony had the turkey; that's $2.10. . . ."

Author's Note: Radio Shack has issued a new disk system manual, which corrects some of the initial documentation problems. However, the new manual needs further refinement. In addition, I understand the "append" command is not supported under version 2.1.

A Look at TRS-80 Peripherals

Three peripherals for the TRS-80 (expansion interface, line printer, disk drive) are reviewed.

Robert Cowan
PO Box 2143
Augusta ME 04330

Since the introduction of the TRS-80 there has been considerable discussion of the potential for expansion and acquisition of more advanced attachments. This article will review three of the peripherals: expansion interface, line printer and disk drive.

First, I should note that this machine is being used in a business setting for a variety of applications (see Photo 1). Most notably it is used to evaluate questionnaires, perform statistical analysis and generate management reports. I've tried to be frank in this article and hope my comments will initiate a nuts-and-bolts exchange whereby users with diverse interests and experiences can share their findings.

Expansion Interface

This unit serves three functions: It acts as a switching and routing device between the other peripherals such as the cassette recorders, line printer, screen and quick printer and disk units; it provides space for the addition of either 16 or 32K of memory; and it contains a real-time clock.

The unit uses a power supply similar to that of the TRS-80, and there is space within the expansion interface for both supplies (Photo 2). The advantage is a reduction in the general clutter that accumulates as you add peripherals. The disadvantage, however, is that the TRS-80 becomes less portable. Originally, I was able to place the TRS-80 in my briefcase and take it home. Now, with the peripherals, I find it increasingly difficult to just pick it up and move it somewhere else.

My first reaction was that the cost of the expansion interface, without any memory, was high ($290). However, since no one else had a similar interface unit on the market, I was limited in my choices. I have just added an additional 32K of memory with chips from Bill Godbout. I must say that the price was exceptional ($109 for 16K), and the instructions were clear and precise with excellent pictures for guidance.

There is little in the way of directions that accompany the expansion interface. The instructions talk of the disk capabilities, the advantages of two cassette units and connecting the hardware. My copy of the directions was a very early edition with mistakes relating to the hookup of the cassette machines. I hope that those mistakes have been corrected.

The interface has several openings for the connection of other equipment:

- An edge connector for the TRS-80 itself.
- A Centronix-type parallel port for the line printer.
- A port for the screen or quick printers.
- A port for the disk drives.
- Two connection points for the cassette machines.
- A connection point for the cassette audio and for switching from the TRS-80.

There is one additional port on the expansion interface for "future expansion," but nothing substantive is said concerning pin connections or how users might access the TRS-80 through the port. I assume that this future port will be the input/output area vaguely referred to in the *Level II Manual* as the way you can use the TRS-80 for security purposes and to control other devices.

I was slightly disappointed that nothing was said in the manual about how you might use the INP and OUT commands. Here I must admit to a total lack of digital knowledge and welcome any input from those who have made use of the INP/OUT commands.

As a parting remark: The TRS-80 TV monitor will sit on top of the expansion interface, although long-term users may find that eye fatigue is less severe if the monitor is placed a little further away from the operator. It is disappointing that the cables that interconnect the expansion interface with

Photo 1. The author's TRS-80 system including expansion interface, line printer and disk drive. (All photos by Richard Riley.)

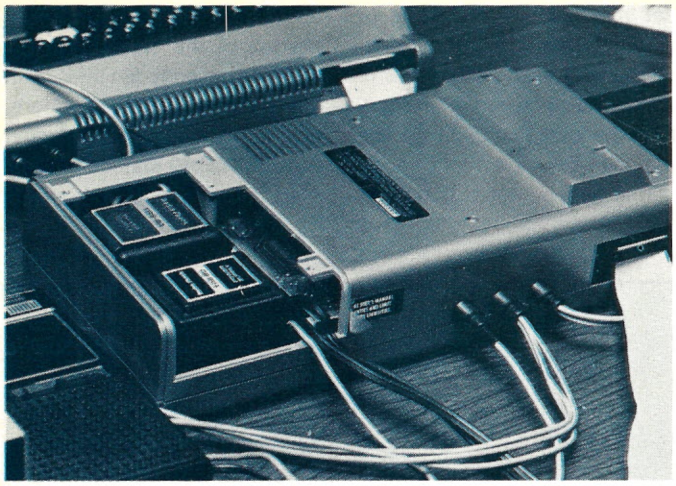


Photo 2. The expansion interface.

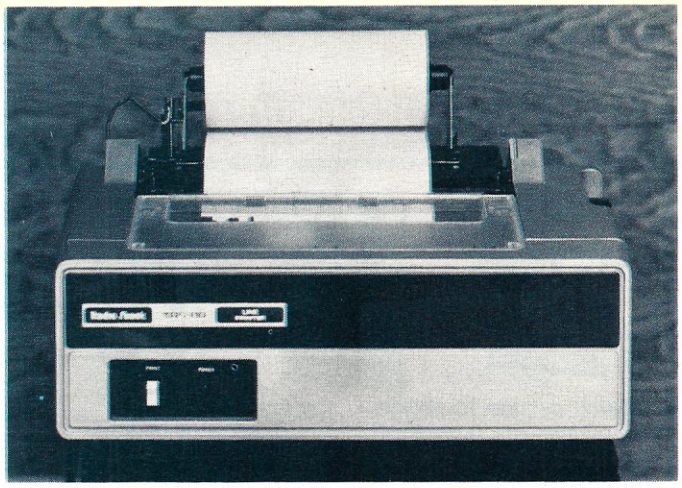


Photo 3. Radio Shack's line printer.

the cassette machines are just a little too short. I suggest either making your own with plenty of extra cable or moving the monitor off to the side and putting the cassette machines on top of the expansion interface.

Finally, I was most disappointed that I could not access the expansion interface's internal clock without the disk system, but I understand that it is possible to access the clock with some sort of machine-language program. Overall, the expansion interface is an expensive addition if all you want is two-cassette capability. But the potential of the device is realized once you add a disk system, printer and more memory.

Line Printer

I'll state at the outset that I like the printer *very* much. It is well built and certainly adds to the flexibility of the system. As I understand it, the line printer is made for Radio Shack by Centronics and is similar to the Centronics 779 (Photo 3).

Briefly, the 45 lb (20 kg) unit is a 5 by 7 dot matrix friction or tractor feed printer with a continuously variable printing density of 10 to 16.5 characters per inch. As the character density increases, the print speed also increases. According to Radio Shack's specifications, the print speed varies between 60 characters per second at the 10 characters-per-inch setting and 100 characters per second at the most dense setting.

The printer maintains a six-lines-per-inch vertical spacing. The print is clear and highly readable. I prefer 12 to 10 characters per inch for readability, but the 16.5 characters-per-inch density is also readable with a little concentration. Fig. 1 shows examples of the density extremes. The printer produces only uppercase characters, and no TRS-80 graphics are supported.

The line printer comes from the factory with a 132-character buffer line length. The service manual, however, notes that you may customize the buffer length to suit your individual needs. While I have not modified my buffer length, I must admit that the thought to do so has crossed my mind more than once. As those of you with Level II realize, each program line can be packed with up to 255 characters.

When listing a program on the printer, you must make sure that the characters-per-inch adjustment is set so that the 132-character buffer prints on the 9.8-inch width paper and doesn't run off the page. The relatively high density that results from setting the printer so that all 132 characters fit on the page does make the debugging process more difficult. An 80-character buffer would allow for a larger, more legible print.

The directions and service manual are clear and extremely complete. I have some general criticisms of the TRS-80 manuals, with the exception of the Level I book, but the Centronics-authored manual is very complete and helpful.

The friction feed line printer uses roll-type paper on a one-inch core. The printer I have uses a friction drive similar to the paper advance found in most home typewriters. One of the common problems with friction feed units is inconsistent alignment of the paper over a long period of time. To counter this problem, many industrial printers use a tractor feed or drive. The tractor feed is a sprocket-based system that uses the side holes in the paper to maintain alignment.

In discussions with Centronics, I have found out that it is possible to retrofit the friction feed units with a tractor system, which might be preferable in a business setting since many printed forms are available in a tractor feed format. The cost for the tractor drive modification is in the neighborhood of $400. Subsequent to my purchase of the friction feed printer, Radio Shack added a tractor feed model to their line for about $300 more than the friction unit.

There are some printer manipulation errors in the manuals. It is my understanding that only two carriage control commands are valid: LPRINT CHR$(12) for top-of-form and LPRINT CHR$(138) for single line feed. The other commands listed for the printer are either nonfunctional or erratic.

I'll digress just a moment to pass along some information concerning the top-of-form command. Memory location 16425 contains the line counter information, and location 16424 contains the number of lines per page, which is set at 66 on power-up. At the conclusion of each line printed, location 16425 increments by one until 66 is reached and is then reset to zero.

The LPRINT CHR$(12) command will cause the printer to feed vertically until the line counter (16425) equals the defined lines per page and then stops the vertical movement of the printer. All you have to do is

```
THIS IS THE MOST DENSE SETTING...
1234567890

THIS IS THE LEAST DENSE SETTING...
1234567890
```

Fig. 1.

set the line counter equal to zero before the first print statement and execute a top-of-form command when you're finished, and the computer will do the rest (see Example 1).

It should be noted that most output, if the paper remains at the top of the paper tear bar, will start seven to ten lines from the top of the paper. Therefore, you might use the command POKE 16425,10 instead of zero. Also, since most people prefer

```
10  POKE 16425,0
20  LPRINT "THIS IS THE FIRST LINE"
    .
    .
    .
    .
50  LPRINT "THIS IS THE LAST LINE"
60  LPRINT CHR$(12)
70  END
```

Example 1.

```
100  IF PEEK(16425)=59 THEN LPRINT CHR$(12)
```

Example 2.

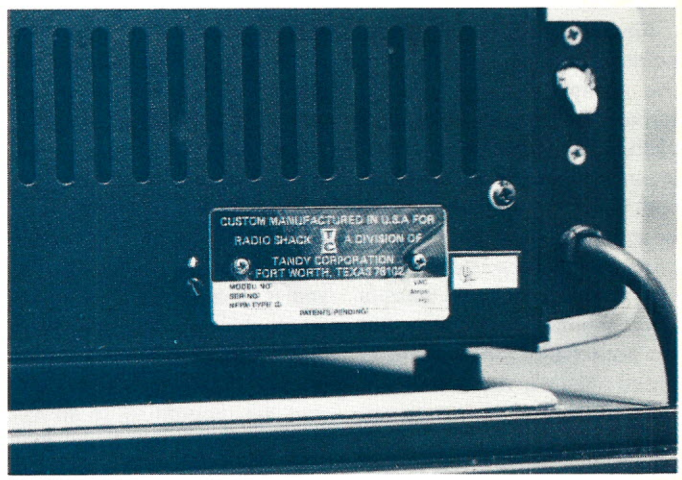


Photo 4. The rear panel of the line printer where the power switch and the print density control are inconveniently located.

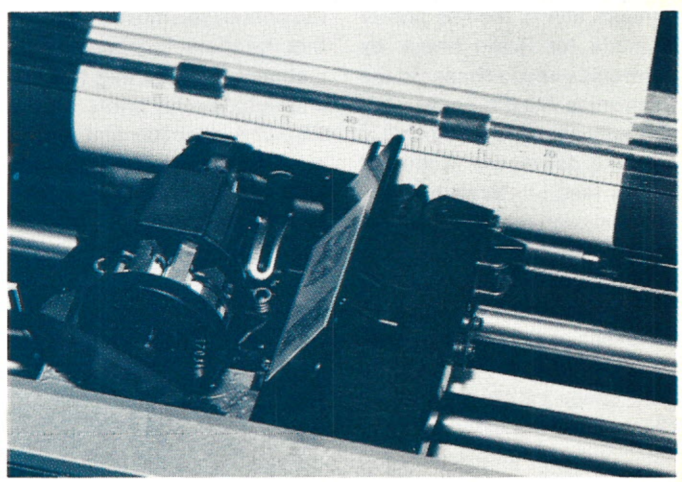


Photo 5. The ribbon mechanism.

Reader Service—see page 179

a one-inch margin at the bottom of the page, you might add a statement to cause the printer to automatically go to the top of the next page as soon as the printer gets within an inch of the bottom of your defined page (see Example 2).

Remember: You can change the defined page by simply using the command POKE 16424,60. You can put in any number you wish, but you must remember that on power-up it is set equal to 66.

Observations

From a user's standpoint, I have several observations. First, the printer is noisy. I've seriously been considering building or buying some sort of sound blimp or acoustic chamber. The printer noise becomes irritating when long programs are printing or when the machine is just idling close to the operator.

Second, the printer power switch, located on the rear panel (Photo 4), is awkward to reach.

Third, the print density control is also located *very* inconveniently on the rear panel (just to the left of the serial plate in Photo 4). I don't know about other users, but I use a variety of density settings depending upon the output requirements, and the screwdriver slot pot just does not meet my needs. As soon as I get some time, I will move the pot to the front panel with a calibrated dial so that users can set the density to meet their needs.

Fourth, changing the ribbons must be one of the most frustrating experiences I've had in years. The ribbon is a simple, black, 30-foot continuous ribbon with a 180-degree twist to form a Möbius loop. The diagrams and the directions are simple and concise, but I've yet to have the ribbons unwind as they're supposed to. Normally, I have to carefully monitor the ribbon as it unwinds the first time to make sure it doesn't spill from the rear ribbon container slot (Photo 5).

Probably *the* most frustrating aspect of the ribbon-changing process is the realization that there must be a simpler way. Presently, I go through about two or three ribbons per roll of paper. If I am doing a lot of listing at high print densities, I find I go through ribbons at a much faster rate. I am sure others would obtain different results depending upon their use of the print impression control and how light they are willing to let the print become. Centronics Data Computer Corp., Hudson NH 03051, sells a great ribbon kit for $18, which includes six ribbons and plastic gloves to minimize the mess.

Fifth, maintaining the printer is exceptionally easy. A few lint-free rags and a vacuum cleaner do a very good job of keeping the unit in top condition. Sixth, multipart forms, such as tax reporting and carbonless forms, come out looking very professional. Seventh, the friction feed does permit

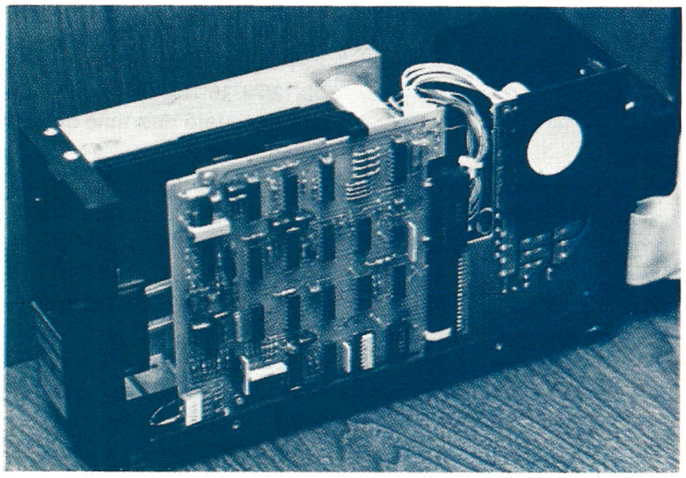


Photo 6. The insides of the disk drive.

the insertion of regular typing paper for some word-processing tasks. I should note that I have been using, without any problems, pressure-sensitive mailing labels designed for a tractor feed.

In summary, I am extremely pleased with my printer. It is very easy to use, and the problems I have mentioned can be overcome without too much trouble. It's funny, though, but as soon as you get the printer running you start printing everything, and the video display gets used very little . . . everything is "hard copy." After a short time, however, reason wins out and you start using both to get your jobs completed faster and with less cost.

Disk Drive

Outstanding! This addition makes you feel like one of the "big boys." The nature of your computing dramatically changes with a disk system; I have been so impressed I have ordered two additional drives to complete my system.

The disk drive is a Shugart diskette unit (Photo 6). The TRS-80 will handle up to four of these drives, one of which must have terminating resistors and be located furthest from the expansion interface. The operation is easy, quick and accurate. Diskettes are easy to insert and remove. The data transfer rate is fast (around 12 kilobytes), and you don't have to worry about volume controls, tape dropouts and other difficulties found with cassettes.

With the disk, the TRS-80 assumes a new posture. I should mention at this point that the disk system gives you three levels of language with which to contend. First, as soon as you turn on the power, the TRS-80 loads the disk operating system (DOS) into memory from the disk drive (Photo 7). The DOS commands allow you to manipulate the disk units; I'll say more about the DOS in a bit.

Second, by typing in BASIC, you have access to all the Level II commands plus nine new BASIC commands and 14 BASIC commands to manipulate the disk drives. Third, if you type in BASIC2, the TRS-80 reverts to the standard Level II BASIC with no new commands and no disk access.

Commands

Let's take a quick look at the new commands available under the DOS:

APPEND—Adds one file to another. (I've never been able to get this command to work.)

ATTRIB—Provides five levels of access and file/program protection. Great feature!

AUTO—Automatically loads a utility program or file on power-up or reset.

CLOCK—Turns on the clock and display (24-hour format).

COPY—Creates duplicate files under new names or onto other disk units.

DATE-TIME—With these two commands you can load the date and time information into memory. See TIME$.

DEBUG—A machine-language debugger that allows for the display of all memory. Since I have little knowledge in this area, I can't speak about its effectiveness.

DIR—Provides the user with the directory of each disk drive. For example, to find out what files are on drive zero and the disk area consumed by each file, the command DIR :0 (A) would display Photo 8. In the EOF section you can see the total number of 256-byte sectors consumed by each file and the total number of half-tracks (GRANS). Exceptionally useful.

FORMAT—Prepares a blank cassette for use.

FREE—Returns the total disk space available to the user.

KILL—Erases a file.

LIB—Lists all DOS commands.

LIST—Displays the contents of a file.

PRINT—Same as LIST, but directs the output to the printer.

PROT—Changes or removes all passwords from the files.

RENAME—Renames a file.

TAPEDISK—Lets you load a SYSTEM program from tape for storage on disk.

BACKUP—Lets you make a complete duplicate copy of an entire diskette.

TRACE—Displays the program counter.

The new BASIC commands available under DISK BASIC are:

CMD"D"—Calls the debugging program from DOS.

MID$—Permits replacement of elements within a string by another string.

INSTR—This command searches to see if a smaller string is embedded in a larger string.

DEF FN—Creates user-defined functions so frequently used formulas can be shortened. Very useful.

&O-&H—Lets you directly enter hexadecimal or octal information.

USR—Permits the user to call up to ten machine-language programs.

DEFUSR—Assigns specific entry points for USR programs.

CMD"T"—Turns off the real-time clock. The clock *must* be turned off before any cassette read/write is attempted.

CMD"R"—Turns the clock back on.

**TIME$**—Returns date and time information. For example, an LPRINT TIME$ would print 02/12/79 16:15:02. At power-up or reset, date and time are set equal to zero.

Also under Disk BASIC are additional commands—GET, PUT, FIELD, LSET, RSET, etc.—to control disk operations. Some of the more notable commands are SAVE and LOAD. These commands allow you to place your programs onto disk and retrieve them. The programs are stored in a condensed format to save disk space. Such items as line num-

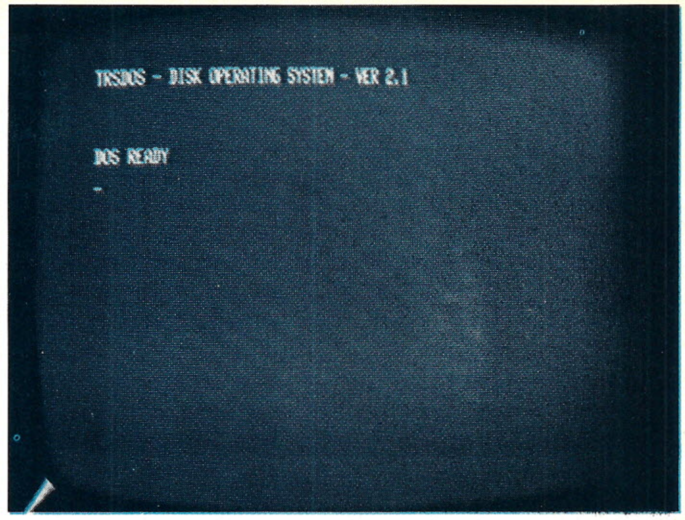


Photo 7. Display when power is turned on and DOS is loaded from the disk drive.

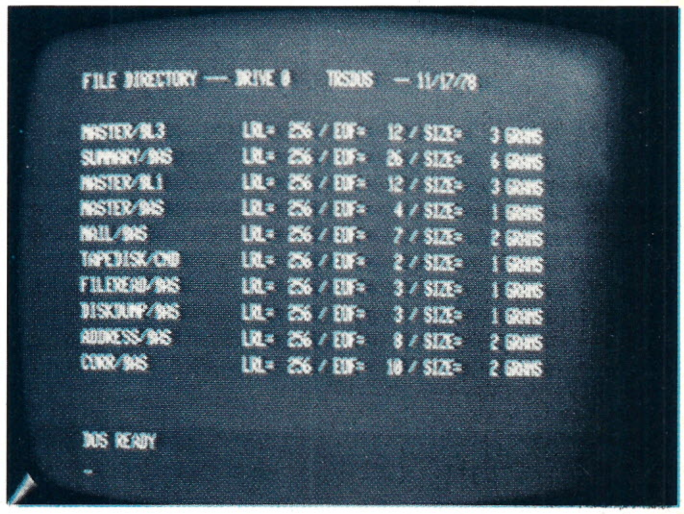


Photo 8. A sample display of the file directory.

bers, statements such as GOSUB are compacted for disk storage. Only the characters in REM and PRINT statements remain totally intact. It is possible to store material in a noncondensed ASCII format if desired.

The speed with which you can load long programs is exceptional, compared with a tape loading. A 2 1/2-minute cassette program will load from disk in approximately ten seconds. Naturally, a major time-saver is storing the majority of your programs on a single diskette and accessing each with a simple LOAD statement followed by a unique name. Each file or program may consist of a one- to eight-character name and extension information if desired. The extension allows for an additional three-letter delimiter to further describe the file, a password and the drive location.

The general format can be seen with the following example, which describes a name and address file, written in BASIC, protected with my name as password and located on disk drive two:

NAMES/BAS.COWAN:2

Without the correct password, you cannot gain access to a program or data file. With the ATTRIB command it is possible for the program author to assign two passwords to a program or file: one that limits access to, say, only reading from a file but no authorization to change, delete or record new information; and a master password that allows unlimited access.

Memory

I should note that the Disk BASIC system consumes a considerable amount of memory. On my 16K system I am left with less than 6K of memory after loading the DOS and Disk BASIC. Although this means a very real limit to program size, I have been able to bypass some of the memory problems by breaking the larger programs into smaller modules and loading only the necessary modules.

For example, one mailing label program has several identifiable components: generating new files, reading and printing from the files, sorting and modifying existing files. As a single program it had insufficient memory to hold the entire program under Disk BASIC, so I divided the program into a series of smaller programs called from disk by a "master" program. As each task is concluded, the small modules call the master program back for further commands.

However, the major problem is a very real reduction in array space with the smaller memory. As you move onto a disk system for inventory control, sorting, etc., the disks, as fast as they are, become slow and awkward. Naturally, manipulating memory is much faster and less prone to I/O errors. Based on my own experience, the 16K memory is serviceable, but either 32 or 48K would be a distinct advantage.

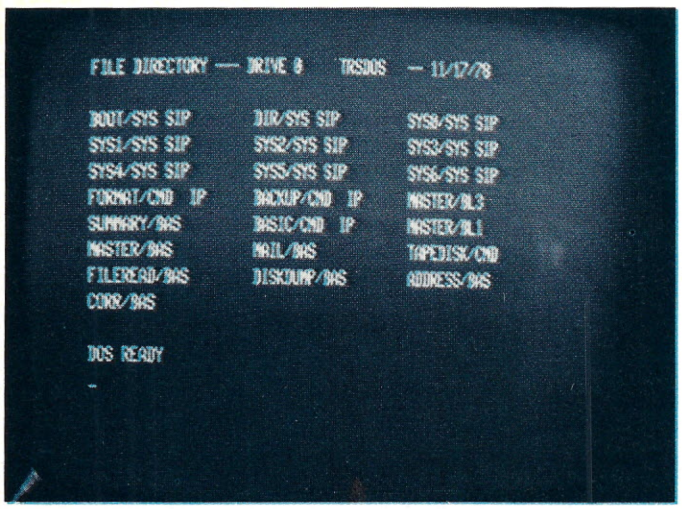


Photo 9. Directory shows 12 tracks occupied by DOS.

Storage

In my application, the disk really shines in the handling of data. Data may be stored in two ways: sequential and random. Sequential storage is almost identical to tape storage. To get anywhere you have to start at the beginning to read anywhere in the data.

There are some shortcomings, however. You cannot add onto a sequential file as you can with a cassette. At the end of each sequential disk file an "End-of-File" character is recorded so that the disk system knows how much space is occupied by the file. Unfortunately, you cannot go back in and erase the end-of-file mark to add more information.

The other method of storing data is by using the random access method. With this approach it is possible to add information, change data when necessary and, if you know the location of the data record, bypass all other data records and go directly to that location—saving considerable time.

To describe the Radio Shack disk system, I should mention that each diskette is divided into 35 tracks (track 0 is furthest away from the center and track 34 is closest to the center drive hole), similar to selections on a phonograph record. Each track is then divided into ten "sectors," with each sector capable of holding 256 bytes of information.

Under the random access method, you are asked to define for the computer your data "record." In the case of a master name file, my record might consist of last name, first name, salutation (for word processing), title, company, address, city, state and zip code. Each area, such as last name, then must be defined in terms of the total number of characters allowed. The combined total of all the entries must not exceed 256 characters, which is the maximum record length and corresponds to the length of a sector.

There are ways to get around this problem if you need more space. If you use less space, the computer will still allocate a full sector for each record, so there are some trade-offs for the speed of being able to access an individual record.

How much information can you store on a disk? That's a good question and I'm not sure I have the correct answers, but I'll pass along my experiences. Radio Shack recently released a new version (2.1) of their DOS, which allows you, for the first time, to monitor how much space has been consumed on a disk and how much remains. If you have only one disk drive, that drive must contain the DOS programs that are used by the TRS-80 to manipulate the disk drive itself.

Of the 35 tracks, 12 are occupied by the DOS, and one is used as a directory so the DOS knows where to go to get a program or data file (Photo 9). The remaining 22 tracks (56,320 bytes) are available to the user. It should be noted that this is less than the number stated in some of the earlier Radio Shack literature. While I have not received my additional drives, I am under the impression that almost 86,000 bytes will be available on each additional drive.

More Observations

After many months of operating the DOS, I am convinced of the effectiveness of disks as a storage medium. However, I have encountered several problems with the DOS, which may be corrected by the time this article appears in print.

First, the DOS documentation is the worst I have seen in over seven years of programming. Required punctuation is either missing or inserted in the wrong places; examples are confusing; commands are nonfunctional. It was very frustrating to receive a disk drive and spend the next month trying to figure out what was going on. I realize that there must have been considerable pressure to

begin shipment, but the resultant manual leaves much to be desired.

Recently, Radio Shack mailed to all its disk owners a new version of the DOS, as I mentioned above, and a new set of instructions covering the changes. A first-rate improvement. The instructions were clear, well written and resembled the format used in larger systems. Some of the commands still do not function, but good proofreading has paid off. I hope the new disk manual is as clear.

A major problem with the DOS (2.1) occurs when you fill the disk to capacity. If you are recording data onto disk and exceed the disk capacity, chances are you will not be able to recover *any* of the data from the disk recorded prior to the overflow. This can be a real problem if the data was entered from the keyboard. As a result of some very bad experiences, I have resorted to running tests prior to the actual recording to determine the disk capacity. It is well worth the time.

I must admit that I have not been too impressed with the Radio Shack diskettes. While running, all of my diskettes made a slight scraping noise, which sent shivers running up and down my back. Recently, I switched to Scotch 744 diskettes, which tempered the aggravation. I should mention that this was an emotional decision—I have never had a Radio Shack diskette fail.

Overview

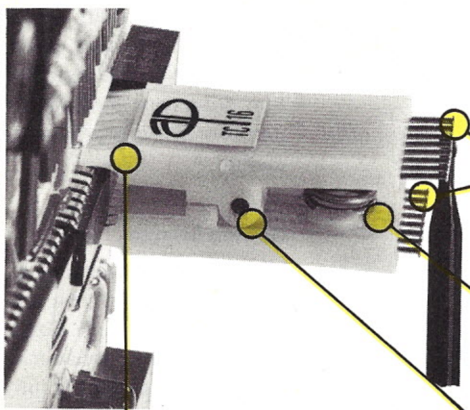
I understand that a whole series of new TRS-80 products is in the works. Recently, the introduction of the new serial interface board (RS-232-C) and Telephone Interface gave rise to the use of the TRS-80 as an intelligent terminal, capable of working with a larger computer elsewhere in the country and performing simpler operations off-line to save telephone and computer costs. I am looking forward to receiving mine.

I have been most pleased with my TRS-80 system. It has done its intended job and then some. It is apparent that Radio Shack is not standing still in the micro field. I'm impressed with the low cost and high performance of its products thus far.

Most of all, I am looking forward to the software that I know will be flooding the market. I certainly anticipate that the field will see great strides over the next year, and I believe this is just the beginning of the "great microcomputer invasion" that has been talked about for many years. ■

NEW.

Meet Super Grip II, the great new test clip from A P Products.



New "duck bill" contacts are flat, won't roll off IC leads.

Open-nose construction enables probe at IC leg.

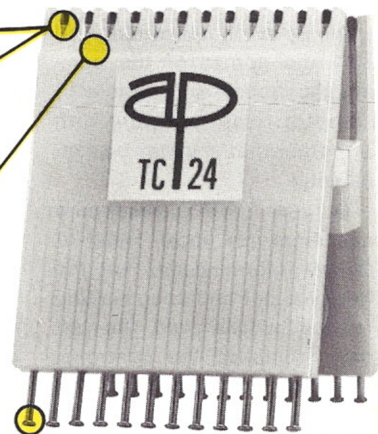
Pin rows are offset for easy attachment of probes.

Contacts are gold-plated phosphor bronze. "Contact comb" construction separates contacts with precision. No shorts.

Heavy-duty, industrial-grade springs for firm contact pressure—and a good grip when pulling ICs. They'll keep their spring indefinitely. No intermittents.

New narrow-nose design makes it easy to attach on high-density boards. And now you can test ICs with only .040" between opposing legs.

Steel pivot pin. Engineering-grade thermoplastic body molded around contact pins. Made to last!



New button-head pins keep probes from sliding off. (Straight pin models for logical connections.)

The new A P Super Grip II is, without question, the best way there is to troubleshoot DIP ICs.

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Heath H8 Disk System

This system review should help you make comparisons when you decide to buy.

Ron Rocheleau
86 Edsel Road
Littleton MA 01460

Well, I finally did it! I'd been putting off writing an article for *Kilobaud* for over a year. This review of the Heath H8 Disk System will bring out the major features of the system. I will include a listing of all the commands and, in some cases, explain how the command is used. By at least providing you with the names of the commands, I hope it will be easier to compare Heath software with any other that you may be considering.

On July 7, 1978, I received a call from my local Heathkit Center informing me that the floppy disk I had been waiting for had finally arrived. The next day I installed the controller and drive and in a few hours had completed the initial setup of the software. The installation was well documented, and as the unit came completely assembled it was a snap to install. The hardware appears to be well designed and constructed; the software is *dynamite*!

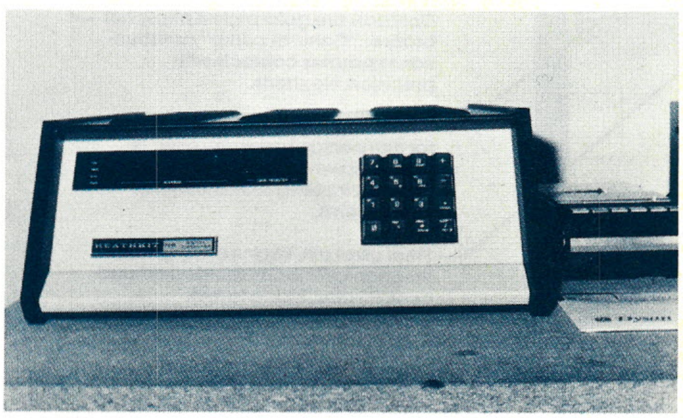
The Drive

The drive is the Model 82 manufactured by Wangco. To the drive mechanics, Heathkit added the necessary power supplies (+5 V dc, +12 V dc), a cabinet suitable for mounting two drives and the device controller to interface with the H8 bus structure. The vital statistics are:

- 5.25 inch minifloppy diskette
- 300 rpm rotation speed
- 102,400 bytes of data storage
- 40 tracks—.013 inch wide each
- 256 bytes per sector
- 100 msec latency time
- 30 msec guaranteed track step time (can be programmatically optimized for as fast as 8 msec step time on some drives)

The Controller

The controller also came completely assembled and ready to plug in. The controller contains all of the circuitry for starting and stopping the drive motors, engaging and disengaging the read/write head positioner, positioning the read/write head over the desired track, selecting unit 0 or 1, converting parallel-to-serial and serial-to-parallel data and formatting the data for writing on the disk. In addition, the controller contains 2K bytes of ROM for disk utility subroutines and 1K of user write-protected RAM for data buffering.



H8 computer.

Software

The software provided by Heath is among the best around for a hobby system. Each new software product announcement from Heath has added new and more powerful features. The Heath Disk Operating System is exceptionally well designed and complete.

The operating system, utilities and system software, a total of 31 programs, comes on a write-protected diskette. The following are included:

HDOS Heath Disk Operating System
SYSGEN to create a user copy of the software
TEST17 disk diagnostic
INIT17 diskette initialization program
TXTCON converts Edit files from cassette to diskette
BASCON converts BASIC programs from cassette to diskette
ONECOPY copies files from diskette to diskette with only one disk drive
FLAGS program to set flags to write-protect a file and set listing options
SET optimizes software for best operation based on the characteristics of the peripherals
PIP provides device-independent file manipulation
DBUG debugs machine-language programs
EDIT text editor
ASM assembler
BASIC Heath Benton Harbor Extended BASIC

In addition, utility programs used by HDOS and three assembly-language demonstration programs and one BASIC demonstration program are included.

Getting Started

Before the system can be operated for the first time, a blank diskette must be initialized and a test routine must be run to ensure that the system is fully operational.

INIT17 is used to initialize the diskette and place a label and volume number on it. The initialization process takes about half a minute. If there are any bad sectors they can be removed from the disk directory, and HDOS will no longer try to read or write the bad sectors.

TEST17 is used to verify and, if necessary, adjust the drive rotation speed. A number that indicates the speed is displayed on the H8 front panel LEDs; if the speed is not within specs, a pot on the drive is adjusted slightly until it is. Next, a general checkout of the drive and

controller can be performed. The test, which takes about 45 minutes to complete, appears to be quite comprehensive.

Another feature is a test for bad sectors on the diskette. If any bad ones are found, this information can be passed on to HDOS through INIT17 when the diskette is initialized again.

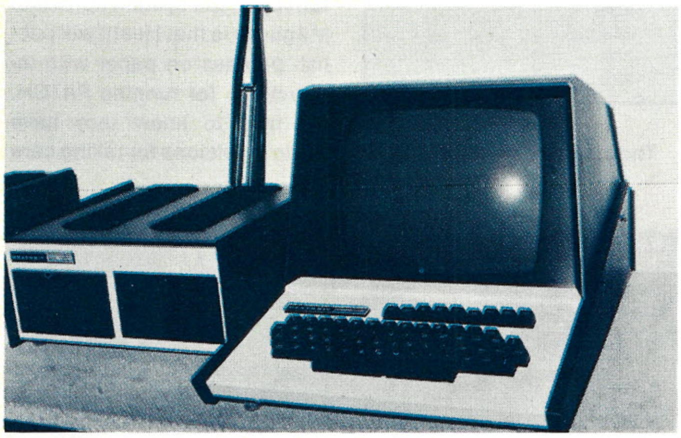
The last test is a seek-step time check. The drive is guaranteed to have a seek-step time of no more than 30 msec. This test will try faster seek-step times to determine the fastest reliable seek time. My disk was capable of 8 msec.

After running TEST17, INIT17 must be run again as TEST17 erases the diskette. The next step is to run SYSGEN. SYSGEN will copy the 13 system programs from the distribution diskette to the initialized blank diskette, which will be used for normal day-to-day operations. The distribution diskette cannot be used for day-to-day operations because it is write-protected. SYSGEN only takes a minute or two to complete.

Now a program called SET, which will allow the user to customize the software for his system to operate at peak efficiency, can be run. The options that can be changed are:

1. seek-step time (determined by TEST17)
2. back space and delete handling for CRT terminal or TTY
3. tab handling
4. number of stop bits
5. line width
6. number of pad or fill characters needed by the console

After optimizing the system, the user runs ONECOPY to load the rest of the system programs as needed. This includes BASIC, EDIT, DBUG, ASM, TXTCON, BASCON and several others. Only those programs desired for the particular diskette's application need be loaded, which will leave as much free space as possible for user programs on the diskette.



H17 disk and H9 terminal.

Running the System: HDOS

Now that the system is fully SYSGENed and configured, it's time to run the disk and learn its powerful operating features. HDOS is in control of the system no matter which program is running along with it. HDOS takes care of all disk transfers and error messages plus the general housekeeping required.

In command mode, the following commands are available from HDOS:

HELP	prints commands available on the console
CAT	prints the names of files on the diskette
COPY	copy from file to file
DATE	set or display the date
DELETE	remove a file or program from the disk
DISMOUNT	orderly shutdown of a disk for removal
PIP	execute PIP
MOUNT	put a disk drive on line and open the directory
RENAME	rename a file
RUN	run a program
SET	run SET to change system optimization
SET HELP	documentation for SET
STATUS	display disk statistics
TYPE	type file contents on terminal

As you can see, the command list is fairly extensive and allows the user much flexibility in managing the system.

HDOS resides for the most part on disk. Usually only about 2.5K of RAM at the top of memory is being used by HDOS. Overlays are used to bring in machine code as needed from disk into this 2.5K area. After running the code, the next overlay required is brought into memory. In this manner the operating system does not require great amounts of memory.

Console Debugger: DBUG

DBUG allows the user to enter and debug machine-language programs. The program is capable of performing nine major functions:

1. display contents of a memory location
2. alter contents of a memory location
3. display contents of any 8080 register
4. alter contents of any 8080 register
5. execute the user program in single-step mode
6. execute the user program
7. insert up to eight breakpoints
8. load the program from a device
9. dump the program to a device

Text Editor: EDIT

The text editor is a program that converts the console terminal into a sophisticated typewriter and also has useful editing capabilities. The text editor is not as easy to use as some I've employed on other systems, but it will satisfy most users. The commands for EDIT are:

BLITZ
BYE
DELETE
EDIT
FLUSH
INSERT
NEWIN
NEWOUT
NEXT
PRINT
READ
REPLACE
SEARCH
USE
WRITE

Assembler: ASM

ASM is the 8080 instruction-code assembler. Programs written in 8080 assembler-code format with the Heath Text Editor, EDIT, can be assembled into machine code. ASM produces a listing file as well as an executable binary file on disk as output.

ASM supports pseudo op codes and directives in addition to 8080 code. DB, DS, IF, ELSE, END, EQU, ORG and SET are included. Also, a directive called XTEXT can be used to get assembly-language routines that reside on disk and add the code from this file to the program being assembled. This feature is similar to the MACRO directive on other assemblers.

Heath provides a file called HDOS.ACM on disk which contains code for input and output to and from the console terminal and exiting from the program to HDOS in an orderly manner.

By using these routines, a programmer can have input and output with the keyboard niceties of all Heath software products by adding only a few instructions to a program instead of having to write a terminal device handler for each program from scratch. Several demo programs are included on the disk provided to better explain how to use this versatile feature.

Assembly on disk is fast. Some switches are also provided for controlling the way the output listing will look.

Extended Benton Harbor BASIC

Extended Benton Harbor BASIC #110.00.00 is a new ver-

sion of Heath's BASIC. Several commands have been added to take advantage of disk files, and a few other commands and functions have also been added. The USR command has been removed.

Previous versions of BASIC have supported a unique Heath idea call *command completion.* Command completion allowed the programmer to type in a sort of shorthand with the computer filling in parts of words.

It was a bit disconcerting to learn, but once you got the hang of it typing speed was increased and typing errors were decreased. I guess enough people complained that Heath removed this feature from their new BASIC. I liked it and would have liked to see it remain . . . at least as an option.

The commands are as follows:

BUILD
BYE
CONTINUE
DELETE
FREEZE
OLD
REPLACE
RUN
SAVE
SCRATCH
UNFREEZE
CHAIN
CLEAR
CONTROL
DIMENSION
FOR/NEXT
FREE
GOSUB/RETURN
GOTO
IF/THEN
LET
LIST
LOCK
ON/GOSUB
ON/GOTO
OUT
PAUSE
POKE
PRINT (#)
READ/DATA
REMARK
RESTORE
INPUT (#)
LINE INPUT (#)
STOP

Predefined functions are:

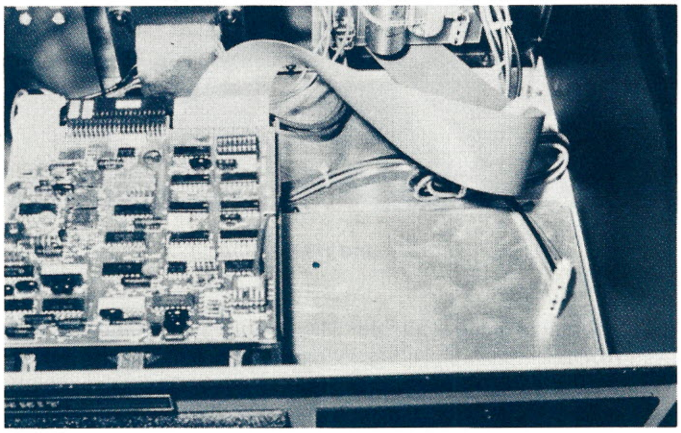
ABS
ASC
ATN
CHR$
CIN
COS
EXP
INT
LEFT$
LEN
LNO
LOG
MATCH
MAX
MID$
MIN
PAD
PEEK
PIN
POS
RND
RIGHT$
SEG
SGN
SIN
SPC
SQR
STR$
TAB
TAN
VAL

The command set is one of the best around, though there is room for improvement. BASIC has a command (CNTRL 4,1) to bring an additional 2.5K of HDOS into memory if the memory is not needed for the BASIC program that is running. This increases the speed of some operations by reducing the number of overlays used by HDOS.

There are a few changes that I personally would prefer. First, I would like more than 6.9 digits of accuracy for arithmetic functions. Second, a syntax check is performed on each block of a program as it is loaded from disk. This makes loading unnecessarily slow and is an annoyance to me when chaining programs together. I would like to see the syntax check performed on a SAVE command and as an option on an OLD command to check programs that have been revised by the EDIT program and eliminated from the chain command. Third, make command completion an option. Fourth, incorporate a simple character-oriented text editor into BASIC.

Patching Software: PATCH

This program is not explained in the write-up that comes with the disk system. I assume it will be used to patch any bugs that turn up in the system software. My guess is that Heath will publish patches on paper with instructions for running PATCH. It's nice to know they have made provisions for taking care of any problems that may arise.



H17 drive electronics power supply in rear of cabinet. Connection for second drive is in front right.

Copying with One Disk Drive: ONECOPY

As mentioned earlier, ONECOPY is used to copy programs and files between diskettes with only one drive. The way this works is to read as much of the data into memory as there is room for; then ONECOPY prompts the user to remove the source diskette and install the destination diskette.

The contents of the memory buffer are then written to the destination diskette. Another prompt informs the user to reinstall the source diskette.

This process continues until the transfers are complete. This program therefore allows a single-drive owner to back up important files on spare diskettes without spending the extra cost of a second drive. If the user has a second drive, he can copy files directly from one drive to the other using HDOS in command mode or PIP.

Closing Comments

I think I've mentioned the most important highlights of the hardware and software, but many finer points are covered in the reference manual. Heath has an outstanding reputation for providing excellent documentation, and that supplied with their computer products certainly is the best I've seen. More than 330 pages of documentation come with the disk.

One other point is that after installing the disk the user may find he needs or desires more memory. This depends on his applications. I have 24K of RAM and find that my longer programs which barely fit before (Star Trek, Financial Analyzer) will no longer run without modification because 2.5K of memory has been taken over by HDOS.

Of course, since a CHAIN command is available in BASIC, each of these programs can be subdivided into smaller sections and chained together to run in less memory. The tradeoff involves a loss of speed. For the time being I am using this method, but as soon as I can save up enough money I plan to add another 16K.

My impression of the hardware and software that makes up my system is that it's one of the best around for the hobbyist, and perhaps as new programs and languages are developed for the H8 it will be a good system for small business to consider as well. Assembled versions are going to be available soon, so the non-kit-builder can get one, too.

Since September 1977 I've had the H8, which has performed reliably and well. I did have a bad memory chip but quickly replaced that at the local Heathkit Center. Heath has made no bones about supporting their hardware and software for years to come.

If you're looking for a system to get started with and grow with, compare the H8 and HDOS with others at the same price level. I think you'll go with Heath also.■

DOTS

Part 1 of this article (February 1979, page 84) introduced some theory on software character generation. This time around, you'll find out how to generate characters on the 1802.

Tom Pittman
PO Box 23189
San Jose CA 95153

n Part 1 of this article (February 1979, p. 84), I discussed the program logic and philosophy behind a software character generator. This month, we'll look at the specific routines that implement the program in the RCA 1802.

1802 Program Notes

While I realize that many of my readers are not familiar with the RCA 1802, this article is not the place for a tutorial in the instruction set. I wrote such a tutorial, which is available from Netronics, 333 Litchfield Rd., New Milford CT 06776, for $5. Therefore, I will assume my readers have a reasonable familiarity with the 1802 instruction set for the remainder of this article.

I think the first order is to give a general feel for the support code that goes with the Dots subroutine. Besides the character generator subroutine itself, there is a keyboard input routine that waits for EF3, then reads input port 7. The character is also echoed to the display.

As a kind of shell around the display driver, there is a little routine that looks for a line feed to come by then turns on the display for a quarter second. It also turns on the display whenever EF4 is true, holding the display on in that state indefinitely, while looping on EF4.

These two routines are required to interface the 1861 to Tiny BASIC because there is a design error in the display chip, and three-cycle instructions usually cause the TV to lose sync.

Tiny BASIC is full of long branches and skips, and I am not about to rewrite it. So, for aesthetics, the program turns off the TV chip during computation and turns it on again when input is requested, briefly after each line feed and whenever EF4 is true. During these times the program is carefully limited to portions of the code with no three-cycle instructions.

I have also included a little main routine with the requisite subroutine linkage routines (these are already in Tiny BASIC, so they are not really a part of the video display driver).

Last, but by no means least, is the interrupt service routine that controls the DMA register. It also maintains a real-time clock as long as the display is turned on (when it is turned off the clock stops!), which is used by the input routine to time the blink on the cursor.

Sample Tiny BASIC output program listing with program output. The program shown made the display of itself then went on to terminate with an error message. I stopped the display at the desired point by holding down EF4 until I took the picture.

Interrupt Service Routine

The interrupt service routine is similar in concept to that described in the RCA data sheet for the 1861. When the interrupt arrives, the first instruction is a three-cycle NOP to restore instruction parity. There are not many different ways to save the necessary registers in an 1802 or to load R0 with the buffer address in preparation for the DMA.

There are exactly 29 memory cycles after the interrupt cycle before the first DMA burst. Eight of them are taken up by the conditional branch BN1. Why so many? *Well* I'll tell you.

When I first wrote this routine, I had in here the code to save the carry and to set X=0 (which I used later on). But for weeks the program kept mysteriously crashing at inopportune moments. It was obviously a timing error, and it was obviously related to this part of the program, since the rest of it would run for hours with no ill effects.

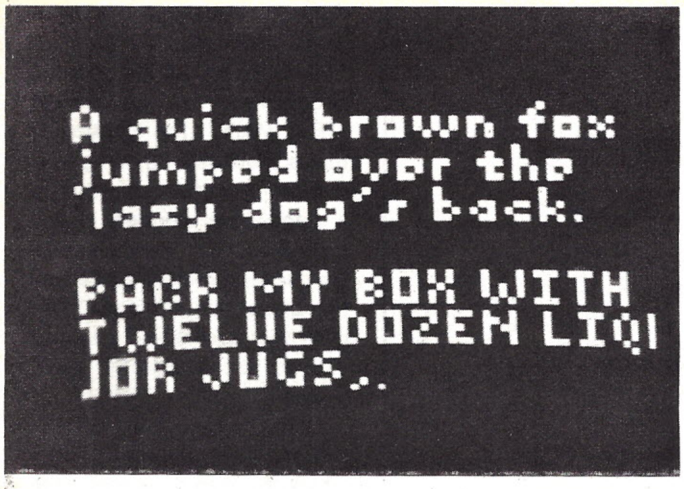
Eventually I noticed that the crash usually took the form of some bytes in lower memory that were being clobbered. But still no clue as to the cause. At least it was the same two bytes, and they always got the same wrong data.

No address register ever pointed to these bytes at the time of the crash (or so I thought), and, as you know, nothing is stored into memory unless an address register points to it. But a hint showed up on the TV screen: Just about the time of each crash I would get a flash of white on the screen, just as when the TV display chip is turned on but the DMA is running free.

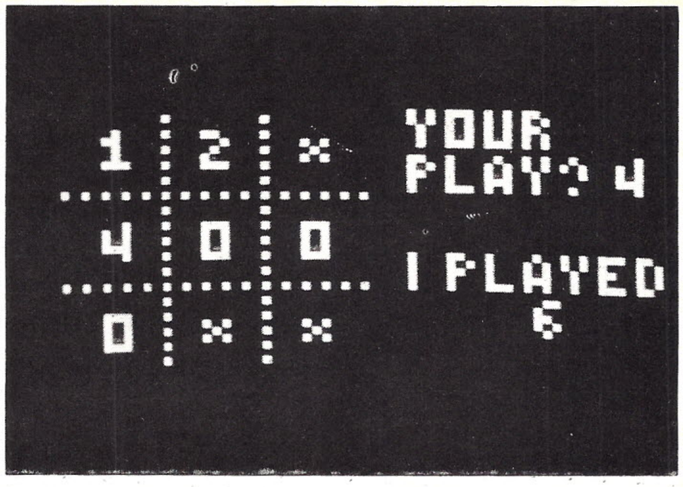
Perhaps, I thought, the DMA is not in sync with the program at this time. If that were the case, the service routine might finish before the DMA did; then when the program went to use R0 as a data pointer to update the real-time clock, the register would begin to walk away.

Sure enough, at the point of the crash (by then I could reproduce the conditions reliably), R0 contained not the address of the time clock but that of one of the bytes being clobbered.

Back to the timing diagrams. I could not see any reason for failure. I dragged out the scope and watched the signals go by. I didn't have a storage scope, and I would not have known what event to trigger it from if I had, so that did not help much. But I guessed that the problem might be related to the timing of three-cycle instructions, so I worked



Sample output, using all letters of the alphabet. This example illustrates the split character, U, on the last two lines.



An actual program in progress. The lines of dots are made by printing periods and colons because Tiny BASIC prints faster than it plots.

up a little test loop that had a variable number of three-cycle instructions in it. Most of them were trapped out by the RCA timing kludge (in the 1861).

Finally, however, I hit on a sequence that delayed the interrupt by two cycles and also shortened the service routine by two cycles. The result was that the DMA started *four* cycles early!

For those of you who are less familiar with the operation of the 1861 display chip, let me fill you in. The 1802 CPU has a built-in DMA capability (actually it is a data channel, not true DMA), using R0 as an address register. Any device can request DMA. If the CPU has properly initialized R0, the time it takes the current instruction to complete R0 is used to address memory, and the peripheral can pass data directly to or from memory, while the CPU continues to generate the read or write control signals. It is amazingly convenient compared to the other CPUs.

The 1861 display controller takes advantage of this and grabs eight bytes at a time for 128 raster lines on the TV. Between these 8-byte bursts there are six more cycles (three instructions) that the program can, and usually does, spend in backing up R0 so that it will display the same eight bytes again.

Thus you can have, at the choice of the software, high resolution (in the vertical direction) with a 1024 byte buffer or low resolution with a much smaller buffer. The COSMAC VIP sold by RCA uses a buffer size of 256 bytes, displaying each eight bytes four times. But if the program does not keep exact track of the number of cycles from the flags that the 1861 waves, it can get out of sync and the DMA can take off uncontrolled.

Back to the program at hand. A 256 byte buffer means only 32 pixels in the vertical direction, or five lines of text. I decided that since many of my characters had an aspect ratio taller than the "golden mean," I could afford to shorten their overall height. Someone, I hear, cut it in half to get ten lines; I thought that was too short, so I went halfway: three raster lines to a pixel. The dots are not so far from square that it is noticeable, but a diagonal line of pixels defines an angle closer to 37° than 45°.

One of the consequences of my unorthodox choice is that the bottom line is only two rasters instead of three. Another is that I cannot conveniently depend on the EF1 signal to tell when the end of the display is imminent.

Instead I positioned the display buffer so that only the last line of eight bytes lay in the last page. When the high half of R0 points into that page, the display is over. This, in case you had not noticed, accounts partly for the odd placement of the code and data in memory. The rest of the reason is to eliminate, as much as possible, the need for long branches.

At the end of the interrupt service routine is a time clock counting routine. TV frames are nominally displayed at 60 per second. In the Netronics system, however, a 3.58 MHz crystal is used, so the actual refresh rate is 60.9928 frames per second. The timer routine therefore counts frames modulo 61, not 60. This still results in an error of about four seconds per hour, so it is not suitable for clock functions without some additional tweaking. But it is not particularly usable from Tiny BASIC because it is turned off most of the time. Oh, well.

Support Routines

Before I get into the guts of the display generator itself, I'll

Program listing.

```
!M
0000 ;          0001 ..  D O T S   -- A TEXT GENERATOR FOR RCA 1861
0000 ;          0002 ..                        .. 1 AUG 78
0000 ;          0003 ..
0000 ;          0004 ..
0000 ;          0005 ..  REGISTER ASSIGNMENTS
0000 ;          0006 ..
0000 ;          0007 ..    0                   .. DMA BUFFER POINTER
0000 ;          0008 ..    1                   .. INTERRUPT PC
0000 ;          0009 ..    2                   .. STACK POINTER
0000 ;          0010 ..    3                   .. MAIN PC
0000 ;          0011 ..    4                   .. CALL LINKAGE PC
0000 ;          0012 ..    5                   .. RETURN LINKAGE PC
0000 ;          0013 ..    6                   .. (NOT USED) RETURN ADDRESS
0000 ;          0014 ..    7                   .. PAGE 00 FETCH PC
0000 ;          0015 BP=   8                   .. SOFTWARE BUFFER POINTER
0000 ;          0016 BC=   9                   .. BIT COUNTER
0000 ;          0017 SH=   10                  .. SHIFT & DECREMENT PC
0000 ;          0018 ..    11
0000 ;          0019 ..    12
0000 ;          0020 PZ=   13                  .. PAGE 00 ADDRESS POINTER
0000 ;          0021 U=    14                  .. LOW BYTE IS TEMP
0000 ;          0022 X=    15                  .. SCRATCH..
0000 ;          0023 AC=   10
0000 ;          0024 C=    12
0000 ;          0025 LDI0= PZ+#90              .. GHI PZ = 1-BYTE CLEAR A
```

```
0000 ;         FECH= #D7              .. PAGE 00 FETCH MACRO
0000 ;         ..
0000 ;               ORG 160
00A0 ;         ..
00A0 ;         ..  TURN ON TV DISPLAY
00A0 ;         ..
00A0 F8C8;     TVON: LDI A.0(INTS)    .. SET UP INTERRUPT
00A2 A1;             PLO 1            .. SERVICE ROUTINE
00A3 F802;           LDI A.1(INTS)
00A5 B1;             PHI 1
00A6 34A6;           B1 *             .. GET OFF EDGE, THEN
00A8 69;             INP 1            .. TURN IT ON
00A9 E3;             SEX 3            .. NOW ENABLE INTERRUPT
00AA 70;             RET
00AB D5;             SEP 5            .. ALSO EXIT
00AC ;         ..
00AC ;         ..  KEYBOARD DRIVER
00AC ;         ..
00AC D70F;     BLNK: ,FECH,A.0(TIME+2) .. LOOK AT TIMER
00AE FE;             SHL
00AF FE;             SHL
00B0 FE;             SHL
00B1 3ABA;           BNZ KEYN+3
00B3 7E;             SHLC             .. AT HALF SECOND,
00B4 D400DF;         SEP 4,A(TVD)     .. TOGGLE CURSER
00B7 ;         ..
00B7 D400A0;   KEYN: SEP 4,A(TVON)    .. TURN ON DISPLAY
00BA 3EAC;           BN3 BLNK         .. WAIT FOR KEYIN
00BC 9D;             ,LDI0            .. OK, TURN OFF CURSER [sic]
00BD D400DF;         SEP 4,A(TVD)
00C0 6F;             INP 7            .. GET KEYIN
00C1 ;         ..
00C1 ;         ..  DISPLAY DRIVER DRIVER FOR TINY BASIC
00C1 ;         ..
00C1 D400DF;   DISP: SEP 4,A(TVD)     .. DISPLAY IT
00C4 AE;             PLO U
00C5 FB0A;           XRI 10           .. IS THIS LF?
00C7 32CD;           BZ HOLD          .. YES
00C9 37CD;           B4 HOLD          .. ALSO HOLD ON EF4
00CB 8E;             GLO U
00CC D5;             SEP 5
00CD D400A0;   HOLD: SEP 4,A(TVON)    .. TURN ON DISPLAY
00D0 F80C;           LDI 12           .. DELAY SOME
00D2 BF;             PHI X
00D3 2F;             DEC X
00D4 9F;             GHI X
00D5 3AD3;           BNZ *-2
00D7 37D7;           B4 *             .. THEN WAIT FOR /4
00D9 E3;             SEX 3
00DA 6100;           OUT 1,0          .. TURN OFF DISPLAY
00DC 8E;             GLO U
00DD 71;             DIS
00DE D5;             SEP 5
00DF ;         ..
00DF ;         ..          (ORG IN LAST 40 BYTES OF PAGE)
00DF ;         ..
00DF ;         ..  CHARACTER FORMATTER (ASCII CHARACTER IN ACC.)
00DF ;         ..
00DF FA7F;     TVD:  ANI #7F          .. TRIM OVERBIT
00E1 AE;             PLO U            .. SAVE FOR EXIT
00E2 E2;             SEX 2            .. SAVE REGISTERS
00E3 8A;             GLO SH
00E4 73;             STXD
00E5 9A;             GHI SH
00E6 73;             STXD
00E7 89;             GLO BC
00E8 73;             STXD
00E9 99;             GHI BC
00EA 73;             STXD
00EB 88;             GLO BP
00EC 73;             STXD
00ED 98;             GHI BP
00EE 73;             STXD
00EF F867;           LDI A.0(SHFT)    .. SET UP SHIFT PC
00F1 AA;             PLO SH
00F2 F802;           LDI A.1(SHFT)
00F4 BA;             PHI SH
00F5 D708;           ,FECH,TVXY       .. GET POINTER
00F7 B8;             PHI BP           .. WHICH IS CURSER
00F8 4D;             LDA PZ
00F9 A8;             PLO BP
00FA 4D;             LDA PZ           .. AND BIT POINTER
00FB FA07;           ANI 7            .. (ONLY WANT LOW 3 BITS)
00FD B9;             PHI BC
00FE D713;           ,FECH,A.0(BS)    .. IS THIS CANCEL?
0100 8E;             GLO U
0101 F3;             XOR
0102 FCFF;           ADI #FF          .. C=0 IF SO
0104 F87F;           LDI #7F
0106 3BE8;           BNF CHAR+1       .. YES
0108 2D;             DEC PZ
0109 8E;             GLO U            .. IS THIS BACKSPACE?
010A F3;             XOR
010B 32AE;           BZ BAX           .. YES
010D 8E;             GLO U
010E FF7F;           SMI #7F          .. IGNORE RUBOUTS
0110 3228;           BZ EXIT
0112 FC5F;           ADI #5F
0114 33E7;           BDF CHAR         .. IT IS PRINTABLE
0116 FC13;           ADI #13
0118 3260;           BZ CR            .. CARRIAGE RETURN
011A FC01;           ADI 1
011C 324E;           BZ FF            .. FORMFEED = HOME CURSER
011E FC02;           ADI 2
```

mention some things of interest in the rest of the program.

Near the end of the program listing is a section labeled "TEST MAIN." The function of this is, more than anything else, to make the published code into a stand-alone program. It also demonstrates a typical call to the display routine (with the control characters 0C and 0A to clear the screen) and a typical call to the character input routine.

This program does nothing with the byte that was input, but all you need to do is insert the desired code before the branch back to get the next character. The character is ready and waiting in the accumulator (and also in the high byte of RF).

The beginning of this routine is devoted to setting up the registers that are used for subroutine calling and returning, and for the little "direct addressing" routine labeled GETZ.

One of the highly touted features for the 6800 and 6502 is the ability of two-byte instructions to directly access the 256 bytes in memory page 00. The 1802 has this feature, too—if you want it. I find it useful, so I put it into nearly every 1802 program I write. It requires a little 7-byte program (six is enough, but by setting X at the same time other things are more convenient) and a few bytes of setup.

You may notice several ",FECH," pseudo-ops in the program. Each one is actually an SEP instruction to call this little routine, followed by the address of the byte in page 00 to be loaded. It is little tricks like this that make the 1802 so versatile.

I will not go into a great deal of discussion on the subroutine call and return technique (RCA calls it "SCRT" in their reference manual). The concept is essentially the same as the FECH pseudo-op: a register is dedicated to point to the respective routine. The SEP instruction referring to that register then becomes the programmed operator to effect that function.

At the beginning of the listing is a routine to turn the TV display chip on. On the Netronics Elf II this is done by an INP 1 instruction. The 1861 is

always keeping track of the frame and outputting sync (albeit messed up badly). When the 1861 is turned on, DMA and interrupts are enabled. The interrupt signal out of the 1861 is true for 28 cycles just before the DMA starts.

But if I happen into this turn-on routine sometime during those 28 cycles, I will get an immediate interrupt without sufficient time to prepare for the DMA. This throws me right back into the R0 morass, so I depend on the fact that EF1, another output from the 1861, brackets the interrupt request. Thus delayed, the DMA will happen anyway, and there may be a flash of white as the DMA runs wild.

But memory is not destroyed because outside the interrupt service routine nothing uses R0, and the interrupt service routine is not entered until the next frame. The screen will probably take a frame or two to snap into registration anyway as it recovers from the ill effects of all the three-cycle instructions. Presumably, after calling TVON there will be no more three-cycle instructions until the display is turned off again.

The keyboard input routine is obvious. The most significant bit of the frame counter is converted into the choice between an SOH (01) and a NUL (00), which respectively turn the cursor dot on or off. The cursor is toggled only if the rest of the byte is all zeros. The display is turned on at that time (and never turned off until the input character is echoed through DISP) and the keyboard is checked. If there is a key-in waiting, the cursor is forced off and the key code is input, then displayed.

The display routine is usually called through the DISP routine, which first goes to the display driver to encode the character, then checks it to see if it was a line feed. If it was, or if EF4 is true, the display is turned on for about 200 milliseconds (more or less) or until EF4 goes false; then it is turned off. Other characters are simply returned with no effect on the display (to turn it on or off) when EF4 is also false.

```
0120 3268;           BZ LF            .. LINEFEED
0122 FC09;           ADI 9
0124 3247;           BZ SOH           .. SOH TURNS ON POINT
0126 3B3F;           BNF NUL          .. NULL TURNS IT OFF
0128 D709;     EXIT: ,FECH,A.0(TVXY+1)
012A 99;             GHI BC           .. SAVE NEW CURSER
012B 73;             STXD
012C 88;             GLO BP
012D 73;             STXD
012E 98;             GHI BP
012F 73;             STXD
0130 12;             INC 2            .. RECOVER SAVED REGISTERS
0131 42;             LDA 2
0132 B8;             PHI BP
0133 42;             LDA 2
0134 A8;             PLO BP
0135 42;             LDA 2
0136 B9;             PHI BC
0137 42;             LDA 2
0138 A9;             PLO BC
0139 42;             LDA 2
013A BA;             PHI SH
013B 02;             LDN 2
013C AA;             PLO SH
013D 8E;             GLO U            .. GET SAVED CHAR.
013E D5;             SEP 5            .. EXIT TO CALLER
013F ;         ..
013F ;         ..  CLEAR CURRENT POINT (NUL)
013F ;         ..
013F F880;     NUL:  LDI #80          .. POINT TO THAT BIT
0141 DA;             SEP SH
0142 FBFF;           XRI #FF          .. MAKE AND MASK
0144 F2;             AND
0145 304B;           BR SOH+4
0147 ;         ..
0147 ;         ..  SET CURRENT POINT (SOH)
0147 ;         ..
0147 F880;     SOH:  LDI #80          .. POSITION THE BIT
0149 DA;             SEP SH
014A F1;             OR               .. TURN IT ON
014B 58;             STR BP
014C 3028;           BR EXIT
014E ;         ..
014E ;         ..  FORMFEED: CLEAR SCREEN
014E ;         ..
014E F83F;     FF:   LDI A.0(BUFX-1)
0150 A8;             PLO BP
0151 F806;           LDI A.1(BUFX)
0153 B8;             PHI BP
0154 E8;             SEX BP
0155 9D;       CLRS: ,LDI0
0156 73;             STXD
0157 88;             GLO BP
0158 FFB0;           SMI A.0(BUFF)
015A 98;             GHI BP
015B 7F04;           SMBI A.1(BUFF)
015D 3355;           BDF CLRS
015F 60;             IRX
0160 ;         ..
0160 ;         ..  CARRIAGE RETURN: TO LEFT MARGIN OF CURRENT LIN
0160 ;         ..
0160 9D;       CR:   ,LDI0            .. THAT IS LEFT BIT
0161 B9;             PHI BC
0162 88;             GLO BP
0163 FAF8;           ANI #F8          .. OF BYTE*8
0165 A8;             PLO BP           .. CANT BACKSPACE FROM HERE
0166 3070;           BR NOB           .. (OR FALL INTO LF)
0168 ;         ..
0168 ;         ..  LINEFEED: GO DOWN 6 PIXELS
0168 ;         ..
0168 88;       LF:   GLO BP           .. TO CURSER POSITION
0169 FC30;           ADI 48           .. ADD 6 LINES
016B A8;             PLO BP
016C 98;             GHI BP
016D 7C00;           ADCI 0           .. CARRY TO UPPER BYTE
016F B8;             PHI BP
0170 ;         ..
0170 D70A;     NOB:  ,FECH,A.0(PSTK-1)
0172 F84E;           LDI BSTK         .. VACATE BACKSPACE STACK
0174 5D;       SSTK: STR PZ
0175 AF;             PLO X
0176 F804;           LDI A.1(BSTK)
0178 BF;             PHI X
0179 99;             GHI BC           .. NEW BIT POINTER
017A FA07;           ANI 7
017C 5F;             STR X
017D ;         ..
017D 88;       SCRL: GLO BP           .. TEST FOR SCROLLING
017E FF08;           SMI BUFE
0180 98;             GHI BP
0181 7F06;           SMBI A.1(BUFE)
0183 3B28;           BNF EXIT         .. NOT OVER
0185 F8B0;           LDI BUFF         .. YES,
0187 AF;             PLO X            .. MOVE BUFFER UP
0188 88;             GLO BP
0189 FCB0;           ADI A.0(BUFF)    .. BY AMOUNT OF OVERSHOOT
018B FAF8;           ANI #F8
018D AA;             PLO SH           .. (THIS IS AVAILABLE)
018E F804;           LDI A.1(BUFF)
0190 BF;             PHI X
0191 7C00;           ADCI 0
0193 BA;             PHI SH
0194 4A;       MOVE: LDA SH           .. LOOP HERE
0195 5F;             STR X
```

```
0196 1F;             INC X
0197 8F;             GLO X
0198 FF08;           SMI A.0(BUFE)     .. CHECK FOR END
019A 9F;             GHI X
019B 7F06;           SMBI A.1(BUFE)
019D 3B94;           BNF MOVE          .. THERE IS MORE
019F 8F;             GLO X
01A0 FF40;           SMI BUFX
01A2 9D;             ,LDI0             .. THEN CLEAR REST
01A3 3B95;           BNF MOVE+1
01A5 88;             GLO BP            .. MOVE CURSER UP
01A6 FA07;           ANI 7             .. TO NEXT-LAST LINE
01A8 A8;             PLO BP
01A9 F806;           LDI A.1(BUFE-8)
01AB B8;             PHI BP
01AC 3028;           BR EXIT
01AE ;         ..
01AE ;         ..  BACKSPACE: DEPENDS ON STACK
01AE ;         ..
01AE D70B;     BAX:  ,FECH,PSTK        .. CAN WE BACK UP?
01B0 AF;             PLO X
01B1 FB4E;           XRI A.0(BSTK)
01B3 3228;           BZ EXIT           .. NOT IF STACK EMPTY
01B5 2F;             DEC X             .. YES
01B6 8F;             GLO X             .. POP THE STACK
01B7 2D;             DEC PZ
01B8 5D;             STR PZ
01B9 F804;           LDI A.1(BSTK)     .. NOW SEE HOW MUCH
01BB BF;             PHI X
01BC EF;             SEX X
01BD 99;             GHI BC            .. SAME WORD?
01BE F7;             SM
01BF 33D7;           BDF BSW           .. YES.
01C1 9D;             ,LDI0             .. NO, CLEAR THIS WORD
01C2 B9;             PHI BC
01C3 DA;             SEP SH
01C4 9D;             ,LDI0
01C5 58;             STR BP
01C6 DA;             SEP SH
01C7 33C3;           BDF *-4           .. 6 LINES
01C9 88;             GLO BP            .. IS THIS A LINE EDGE?
01CA FA07;           ANI 7
01CC 3AD6;           BNZ BSW-1         .. NO.
01CE 88;             GLO BP            .. YES,
01CF FF28;           SMI 40            .. GO BACK 5 PIXEL LINES
01D1 A8;             PLO BP
01D2 98;             GHI BP
01D3 7F00;           SMBI 0
01D5 B8;             PHI BP
01D6 28;             DEC BP            .. NOW BACK ONE WORD
01D7 0F;       BSW:  LDN X             .. GET NEW BIT POINTER
01D8 FA07;           ANI 7             .. (COULD BE VANDALIZED)
01DA B9;             PHI BC
01DB F8FF;           LDI #FF           .. CLEAR RIGHT END
01DD DA;             SEP SH
01DE FBFF;           XRI #FF           .. CONVERT TO AND MASK
01E0 F2;             AND               .. (X=BP)
01E1 58;             STR BP
01E2 DA;             SEP SH
01E3 33DB;           BDF *-8           .. SIX LINES
01E5 3028;           BR EXIT
01E7 ;         ..
01E7 ;         ..  PRINTABLE GRAPHIC
01E7 ;         ..
01E7 8E;       CHAR: GLO U             .. GET IT
01E8 FE;             SHL               .. INDEX INTO CHAR TABLE
01E9 FCB9;           ADI A.0(CTBL-64)
01EB AF;             PLO X
01EC 9D;             ,LDI0
01ED 7C02;           ADCI A.1(CTBL-64)
01EF BF;             PHI X
01F0 D70B;           ,FECH,A.0(MASK-1)
01F2 4F;             LDA X             .. GET BIT MASK
01F3 5D;             STR PZ            .. SAVE IT
01F4 4F;             LDA X
01F5 FCB9;           ADI DOTS
01F7 AF;             PLO X             .. POINT TO DOT MATRIX
01F8 9D;             ,LDI0
01F9 7C03;           ADCI A.1(DOTS)
01FB BF;             PHI X
01FC 99;             GHI BC            .. SAVE CURSER POSITION
01FD 52;             STR 2
01FE 22;             DEC 2
01FF 0D;             LDN PZ            .. POSITION BIT MASK
0200 FA07;           ANI 7
0202 B9;             PHI BC
0203 0D;             LDN PZ
0204 FAF8;           ANI #F8           .. IT IS LEFT 5 BITS
0206 DA;             SEP SH
0207 1A;             INC SH            .. (CANCEL SECOND COCALL)
0208 1A;             INC SH
0209 A9;             PLO BC            .. SAVE MASK,
020A 12;             INC 2             .. AND PREPARE TO
020B E2;             SEX 2
020C 0D;             LDN PZ            .. FIND RELATIVE SHIFT
020D FA07;           ANI 7
020F F5;             SD                .. (X=2)
0210 B9;             PHI BC
0211 89;             GLO BC            .. SAVE NEW MASK
0212 5D;             STR PZ
0213 4F;       CHRL: LDA X             .. GET SOME DOTS
0214 ED;             SEX PZ
0215 F2;             AND               .. MASK TO THIS CHAR
0216 DA;             SEP SH            .. SHIFT IT
```

The display is turned off by an OUT 1 instruction, but the output data is ignored. The interrupts are disabled at the same time, though the 1861 is no longer generating any.

Display Driver

Now we come to the heart of the program. I already discussed the logic, so in this section I will limit my remarks to the details of the code, with emphasis on the less obvious parts.

As I said, I wrote this routine for use with Tiny BASIC. There were few registers lying around after Tiny BASIC took its share, so to get the registers I needed I had to save and restore some.

Three registers are pushed into the stack. One of them becomes the program counter for the shift and count co-routine; one is loaded with the byte address of the pixel the cursor is pointing to; and the third has its high byte loaded with the bit pointer part of the cursor. The low byte of the third register will be used to count the shifting operations.

The analysis of the character to be displayed is quite ordinary, as is the register restoral code at the exit.

Most of the routines in the display program make use of the shift and count co-routine, so I will discuss them first.

In form, the shift and count routines are not much different from any direct call 1802 subroutine. The ultimate exit is placed physically just before the entry so that the address register is set up to recall the routine with a simple SEP instruction. The difference is that I used one address register for two subroutines, knowing full well that almost always they will be called alternately. Therefore, the exit from the first falls into the entry for the second and vice versa.

This is thus the form of a co-routine, but here the calling program always knows which of the two routines will be next to execute, which is a stronger condition than most co-routine applications. Also, it turns out that occasionally the routines are not called in strict alternating

```
0217 F1;               OR           .. INSERT INTO BUFFER
0218 58;               STR BP
0219 DA;               SEP SH       .. UP TO NEXT LINE
021A 3313;             BDF CHRL
021C 0D;               LDN PZ       .. CHECK FOR SPLIT WORD
021D DA;               SEP SH
021E 1A;               INC SH       .. (DONT WANT COUNTER)
021F 1A;               INC SH
0220 3B3C;             BNF CUPD     .. NOT SPLIT.
0222 2F;               DEC X        .. BACK UP DOT POINTER
0223 2F;               DEC X
0224 2F;               DEC X
0225 2F;               DEC X
0226 2F;               DEC X
0227 2F;               DEC X
0228 18;               INC BP       .. POINT TO NEXT WORD
0229 88;               GLO BP
022A FA07;             ANI 7
022C 3A36;             BNZ CFIX
022E 88;               GLO BP       .. OOPS, NEXT LINE
022F FC28;             ADI 40       .. GO DOWN 5 ROWS
0231 A8;               PLO BP
0232 98;               GHI BP
0233 7C00;             ADCI 0
0235 B8;               PHI BP
0236 99;         CFIX: GHI BC       .. CONVERT TO LEFT SHIFT
0237 F9F8;             ORI #F8
0239 B9;               PHI BC
023A 3013;             BR CHRL      .. GO DO IT AGAIN
023C F980;       CUPD: ORI #80
023E 38;               SKP          .. FIND RIGHT EDGE
023F 19;               INC BC
0240 F6;               SHR
0241 3B3F;             BNF *-2      .. OF MASK
0243 89;               GLO BC
0244 FD09;             SDI 9        .. ANY LEFT?
0246 B9;               PHI BC
0247 FF08;             SMI 8
0249 3B58;             BNF CSTK     .. YES.
024B B9;               PHI BC       .. NO, ADVANCE WORD
024C 18;               INC BP
024D 88;               GLO BP
024E FA07;             ANI 7
0250 3A58;             BNZ CSTK
0252 F850;             LDI #50      .. NEXT LINE, ACTUALLY,
0254 B9;               PHI BC       .. SO DROP DOWN
0255 2A;               DEC SH       .. FIVE MORE PIXELS
0256 2A;               DEC SH
0257 DA;               SEP SH
0258 D70B;       CSTK: ,FECH,PSTK   .. UPDATE BACKSPACE STACK
025A 3A5F;             BNZ *+5
025C C00170;           LBR NOB      .. OOPS, STACK N.G.
025F FC01;             ADI 1        .. BY PUSHING
0261 2D;               DEC PZ
0262 C4;               NOP          .. (TO CANCEL LBR)
0263 C00174;           LBR SSTK     .. GO STORE IT
0266 ;           ..
0266 ;           ..  SHIFT MASK RIGHT (+) OR LEFT (-)
0266 ;           ..
0266 D3;               SEP 3        .. EXIT
0267 52;         SHFT: STR 2        .. SAVE BITS TO SHIFT
0268 88;               GLO BP       .. NOTE IF OUTSIDE DISPLAY
0269 FFB0;             SMI A.0(BUFF)
026B 98;               GHI BP       .. (ONLY WORRY ABOUT EARLIEI
026C 7F04;             SMBI A.1(BUFF)
026E 9D;               ,LDI0        .. IF SO, RETURN ZERO
026F 3B90;             BNF SHN+1    .. SO NOT DESTROY PROG
0271 99;               GHI BC       .. LOOK AT COUNT
0272 FA87;             ANI #87      .. MASK OUT WORD COUNTER
0274 A9;               PLO BC
0275 328E;             BZ SHN-1     .. NO SHIFT
0277 FE;               SHL
0278 3383;             BDF SHL      .. LEFT
027A 02;         SHRL: LDN 2        .. SHIFT RIGHT ONCE
027B F6;               SHR
027C 52;               STR 2
027D 29;               DEC BC
027E 89;               GLO BC
027F 3A7A;             BNZ SHRL     .. REPEAT N TIMES
0281 308F;             BR SHN       .. DONE
0283 ;           ..
0283 F6;         SHL:  SHR          .. LEFT SHIFT:
0284 FD08;             SDI 8        .. SET UP COUNTER
0286 A9;               PLO BC
0287 02;         SHLL: LDN 2        .. DO IT
0288 FE;               SHL
0289 52;               STR 2
028A 29;               DEC BC
028B 89;               GLO BC
028C 3A87;             BNZ SHLL     .. REPEAT
028E FE;               SHL          .. CLEAR CARRY
028F 02;         SHN:  LDN 2        .. GET BITS
0290 E8;               SEX BP
0291 D3;               SEP 3        .. EXIT, C=SHIFT OFF RIGHT
0292 3096;             BR *+4       .. SECOND ENTRY
0294 3067;             BR SHFT      .. OPTIONAL RERUNS
0296 ;           ..
0296 ;           ..  COUNT WORDS, MOVING POINTER UP
0296 ;           ..
0296 99;               GHI BC       .. GET COUNTER
0297 FC18;             ADI #18      .. CONVERT IF - ; ADD 1
0299 3B9D;             BNF *+4
029B F980;             ORI #80      .. (RESTORE SIGN)
029D FAF7;             ANI #F7
```

sequence. There are two places in the program where there are two consecutive calls on the shift routine. This is accommodated by the branch that separates the two routines. Normally the next SEP will continue with the BR * +4 instruction, which jumps into the count routine.

In the two cases where another shift is required, the address register is incremented past this branch to point to the branch back to the beginning of the shift routine. I normally would use an LSKP instruction so that only one increment would be required to repeat the first routine, but in this case one of the requirements was the abstention from three-cycle instructions.

The high byte of R9 (symbolic BC) contains both the shift count and the byte count used in the next routine. The low three bits indicate the number of positions to shift, and the most significant bit is the sign. The encoding is such that this byte may be initialized with any (two's complement) signed number between -7 and $+7$, and the byte counter in the middle bits is implicitly set to zero.

In use, the shift amount is not changed throughout the six calls on the co-routine pair. Therefore, it is only necessary to extract the bits that signify the amount and direction. If they are all four zero, then no shift is specified. Otherwise, the sign selects between the left and right shift portions of the code.

The byte to be shifted came into the subroutine in the accumulator and was stored on the top of the stack (pointed to by R2). Each shift routine consists of a simple loop to shift that byte once in the appropriate direction, then decrement the count in the low byte of R9 and quit when done.

The left shift has to do a little setup to convert the negative shift count to a positive number, and one extra instruction at the end to clear the carry. The carry out of the right shift is used to tell whether a character is split across bytes by shifting the mask. The reason for clearing the carry in the case of the left

shift has already been discussed.

The exit from the shift routine sets X = 8 (symbolic BP) so that the calling program can implicitly access the display buffer. This complements R8's initialization with the byte pointer on entry to TVD.

The counting routine has three cases to consider. The first time through with a new count, the count part of the high byte of R9 (that is, bits 4-6) may be either 0 or 7. Both must be interpreted as a count of zero.

There is one other piece of available information to help make this decision: If the bits are ones (i.e., the count value is 7), it is exactly because all five upper bits of the byte are ones for the two's complement representation of some negative shift count. I have arranged it so that in all nonzero byte count values, this is not true. If the four upper bits are ones, then the add immediate of hex 18 will produce a carry.

If bit 3, which is not properly a part of the byte counter, is also one, then there will be a carry out of that bit into bit 4. Bit 3 is subsequently forced to zero so that this never happens again. The result is that the sum out of either case is 1 (see Fig. 1).

The second case is the four calls with a nonzero (i.e., also not 7) count, in which the same algorithm simply adds one to the count in bits 4-6.

The final case is when the count has reached 6 (shifted left, that is, hex C), which signifies the last time through the loop. In this case the count information is stripped off and the original five zeros or five ones are restored to the upper bits by replicating the sign bit. Also at this time the byte pointer must be incremented by 40 (five rows down) instead of the usual subtract 8, which moves the pointer up one row.

Incidental to this addition or subtraction is the carry out. The sum never generates a carry (because the buffer is not split across address 0000), nor does the subtract generate a borrow. In the 1802 a borrow is the complement of a carry; so when this routine exits, the carry is 1 until

```
029F B9;            PHI BC
02A0 FE;            SHL               .. SIGN IN C
02A1 FAE0;          ANI #E0           .. IS THIS END?
02A3 FBC0;          XRI #C0
02A5 3AB9;          BNZ SHNN          .. NO.
02A7 99;            GHI BC            .. YES; RESTORE ORIGINAL
02A8 FA07;          ANI 7
02AA 3BAE;          BNF *+4
02AC F9F8;          ORI #F8           .. (NEGATIVE)
02AE B9;            PHI BC
02AF 88;            GLO BP            .. BUMP BP BACK TO BOTTOM
02B0 FC28;          ADI 40
02B2 A8;            PLO BP
02B3 98;            GHI BP
02B4 7C00;          ADCI 0
02B6 B8;            PHI BP
02B7 3066;          BR SHFT-1         .. C=0
02B9 ;         ..
02B9 88;       SHNN: GLO BP           .. GO TO NEXT LINE UP
02BA FF08;          SMI 8
02BC A8;            PLO BP
02BD 98;            GHI BP
02BE 7F00;          SMBI 0
02C0 B8;            PHI BP
02C1 3066;          BR SHFT-1         .. C=1
02C3 ;         ..
02C3 ;         ..  INTERRUPT SERVICE ROUTINE
02C3 ;         ..
02C3 E2;       INTX: SEX 2
02C4 42;            LDA 2             .. RECOVER CARRY
02C5 FE;            SHL
02C6 42;            LDA 2             .. RECOVER A
02C7 70;            RET               .. EXIT
02C8 C4;       INTS: NOP              .. ENTER HERE
02C9 22;            DEC 2
02CA 78;            SAV               .. SAVE T
02CB 22;            DEC 2
02CC 73;            STXD              .. SAVE A
02CD F804;          LDI A.1(BUFF)
02CF B0;            PHI 0             .. SET UP 0
02D0 F8B0;          LDI A.0(BUFF)
02D2 A0;            PLO 0
02D3 34D3;          B1 *              .. SYNCHRONIZE
02D5 80;       LOOP: GLO 0            .. START DISPLAY
02D6 ;              ...               .. (DMA)
02D6 20;            DEC 0
02D7 A0;            PLO 0
02D8 E0;            SEX 0             .. (NOT A NOP)
02D9 ;              ...
02D9 20;            DEC 0
02DA A0;            PLO 0             .. THREE RASTERS PER PIXEL
02DB 90;            GHI 0             .. LAST LINE
02DC ;              ...
02DC FB06;          XRI A.1(BUFE)     .. IS NEW PAGE
02DE 3AD5;          BNZ LOOP
02E0 B0;            PHI 0
02E1 F80F;          LDI A.0(TIME+2) .. NOW UPDATE CLOCK:
02E3 A0;            PLO 0
02E4 76;            SHRC              .. SAVE CARRY
02E5 52;            STR 2
02E6 F0;            LDX
02E7 FC01;          ADI 1             .. INCREMENT FRAME COUNT
02E9 50;            STR 0
02EA FF3D;          SMI 61            .. ONE SECOND?
02EC 3BC3;          BNF INTX          .. NOT YET.
02EE 73;            STXD              .. YES
02EF F0;            LDX               .. BUMP SECONDS
02F0 FC01;          ADI 1
02F2 73;            STXD
02F3 F0;            LDX
02F4 7C00;          ADCI 0            .. 16 BITS
02F6 50;            STR 0
02F7 30C3;          BR INTX
02F9 ;         ..
02F9 ;         ..
02F9 ;         ..  CHARACTER INDEX AND MASK TABLE
02F9 ;         ..
02F9 ;         M1=    #80
02F9 ;         M2=    #C0
02F9 ;         M3=    #E0
02F9 ;         M4=    #F0
02F9 ;         M5=    #F8
02F9 ;         ..
02F9 ;         CTBL= *                .. FIRST CHAR IS SPACE
02F9 ;         ..
02F9 8608;         ,A.0(M1+6),8    .. SPACE
02FB 820A;         ,A.0(M1+2),10   .. !
02FD E508;         ,A.0(M3+5),8    .. "
02FF F823;         ,A.0(M5+0),35   .. #
0301 E435;         ,A.0(M3+4),53   .. $
0303 E55A;         ,A.0(M3+5),90   .. %
0305 F423;         ,A.0(M4+4),35   .. &
0307 C200;         ,A.0(M2+2),0    .. '
0309 C111;         ,A.0(M2+1),17   .. (
030B C211;         ,A.0(M2+2),17   .. )
030D E03C;         ,A.0(M3+0),60   .. *
030F E547;         ,A.0(M3+5),71   .. +
0311 C307;         ,A.0(M2+3),7    .. ,
0313 C441;         ,A.0(M2+4),65   .. -
0315 8407;         ,A.0(M1+4),7    .. .
0317 E529;         ,A.0(M3+5),41   .. /
0319 E111;         ,A.0(M3+1),17   .. 0
031B E243;         ,A.0(M3+2),67   .. 1
031D E44F;         ,A.0(M3+4),79   .. 2
```

```
031F E103;               ,A.0(M3+1),3   .. 3
0321 E01D;               ,A.0(M3+0),29  .. 4
0323 E042;               ,A.0(M3+0),66  .. 5
0325 E249;               ,A.0(M3+2),73  .. 6
0327 E073;               ,A.0(M3+0),115 .. 7
0329 E303;               ,A.0(M3+3),3   .. 8
032B E049;               ,A.0(M3+0),73  .. 9
032D 8304;               ,A.0(M1+3),4   .. :
032F C335;               ,A.0(M2+3),53  .. ;
0331 E541;               ,A.0(M3+5),65  .. <
0333 E503;               ,A.0(M3+5),3   .. =
0335 E517;               ,A.0(M3+5),23  .. >
0337 E05A;               ,A.0(M3+0),90  .. ?
0339 E079;               ,A.0(M3+0),121 .. @
033B E12F;               ,A.0(M3+1),47  .. A
033D E56D;               ,A.0(M3+5),109 .. B
033F E417;               ,A.0(M3+4),23  .. C
0341 E217;               ,A.0(M3+2),23  .. D
0343 E560;               ,A.0(M3+5),96  .. E
0345 E534;               ,A.0(M3+5),52  .. F
0347 E24F;               ,A.0(M3+2),79  .. G
0349 E33B;               ,A.0(M3+3),59  .. H
034B E117;               ,A.0(M3+1),23  .. I
034D E155;               ,A.0(M3+1),85  .. J
034F E060;               ,A.0(M3+0),96  .. K
0351 E343;               ,A.0(M3+3),67  .. L
0353 F96D;               ,A.0(M5+1),109 .. M
0355 F41D;               ,A.0(M4+4),29  .. N
0357 E017;               ,A.0(M3+0),23  .. O
0359 E573;               ,A.0(M3+5),115 .. P
035B E00B;               ,A.0(M3+0),11  .. Q
035D E53B;               ,A.0(M3+5),59  .. R
035F E029;               ,A.0(M3+0),41  .. S
0361 E066;               ,A.0(M3+0),102 .. T
0363 E21D;               ,A.0(M3+2),29  .. U
0365 E379;               ,A.0(M3+3),121 .. V
0367 FB2E;               ,A.0(M5+3),46  .. W
0369 E260;               ,A.0(M3+2),96  .. X
036B E273;               ,A.0(M3+2),115 .. Y
036D E035;               ,A.0(M3+0),53  .. Z
036F C017;               ,A.0(M2+0),23  .. [
0371 E329;               ,A.0(M3+3),41  .. \
0373 C117;               ,A.0(M2+1),23  .. ]
0375 E200;               ,A.0(M3+2),0   .. ^
0377 E507;               ,A.0(M3+5),7   .. _
0379 C300;               ,A.0(M2+3),0   .. `
037B E184;               ,A.0(M3+1),132 .. a
037D E07F;               ,A.0(M3+0),127 .. b
037F E27F;               ,A.0(M3+2),127 .. c
0381 E30C;               ,A.0(M3+3),12  .. d
0383 E512;               ,A.0(M3+5),18  .. e
0385 E566;               ,A.0(M3+5),102 .. f
0387 E050;               ,A.0(M3+0),80  .. g
0389 E356;               ,A.0(M3+3),86  .. h
038B 8107;               ,A.0(M1+1),7   .. i
038D C007;               ,A.0(M2+0),7   .. j
038F E50C;               ,A.0(M3+5),12  .. k
0391 850C;               ,A.0(M1+5),12  .. l
0393 FB84;               ,A.0(M5+3),132 .. m
0395 E384;               ,A.0(M3+3),132 .. n
0397 E57F;               ,A.0(M3+5),127 .. o
0399 E575;               ,A.0(M3+5),117 .. p
039B E13D;               ,A.0(M3+1),61  .. q
039D C689;               ,A.0(M2+6),137 .. r
039F E589;               ,A.0(M3+5),137 .. s
03A1 E268;               ,A.0(M3+2),104 .. t
03A3 E489;               ,A.0(M3+4),137 .. u
03A5 E289;               ,A.0(M3+2),137 .. v
03A7 F889;               ,A.0(M5+0),137 .. w
03A9 E03D;               ,A.0(M3+0),61  .. x
03AB E555;               ,A.0(M3+5),85  .. y
03AD E47F;               ,A.0(M3+4),127 .. z
03AF E011;               ,A.0(M3+0),17  .. {
03B1 8002;               ,A.0(M1+0),2   .. |
03B3 E211;               ,A.0(M3+2),17  .. }
03B5 E500;               ,A.0(M3+5),0   .. ~
03B7 F203;               ,A.0(M4+2),3   .. DEL
03B9 ;              ..
03B9 ;              ..  PACKED DOT TABLE
03B9 ;              ..
03B9 ;              DOTS= *
03B9 ;              ..
03B9 00008080E897;       ,#00008080E897
03BF A89768404020;       ,#A89768404020
03C5 40ADB6AD4404;       ,#40ADB6AD4404
03CB 2056DD572000;       ,#2056DD572000
03D1 F4AAA9AAF400;       ,#F4AAA9AAF400
03D7 39E9ABAD2900;       ,#39E9ABAD2900
03DD 55FA54F85400;       ,#55FA54F85400
03E3 C024;               ,#C024
03E5 4A91600A5575;       ,#4A91600A5575
03EB 51512014EC86;       ,#51512014EC86
03F1 4C27E4001515;       ,#4C27E4001515
03F7 BE55B60001C2;       ,#BE55B60001C2
03FD 3CD291F01002;       ,#3CD291F01002
0403 572A70A05800;       ,#572A70A05800
0409 DE68;               ,#DE68
040B A4621C062355;       ,#A4621C062355
0411 151810510422;       ,#151810510422
0417 A14400AFACD6;       ,#A14400AFACD6
041D ACAF0042425F;       ,#ACAF0042425F
0423 52F910004645;       ,#52F910004645
0429 566D46009494;       ,#566D46009494
042F 562DEE006894;       ,#562DEE006894
```

```
 00000xxx      11111xxx
+00011000     +00011000
---------     ---------
 00011xxx      00010xxx
              +10000000  (restore sign)
&11110111     &11110111
---------     ---------
 00010xxx      10010xxx
```

Fig. 1.

the last iteration, then it is zero. This is a convenient flag to control the loop in the calling program.

Once you understand the shift/count routines, the control functions for NUL and SOH just fall right out. The high byte of R9 has already been set up with the bit pointer in the cursor position.

Zero represents the left bit (in this program, since the bits are scanned high-to-low in the display). A single bit in the left-bit position is therefore shifted by the amount in the cursor bit pointer, which positions it on the pixel that the cursor points to. This is with one call to the shift routine. Then that bit is either deleted from or added to the display buffer.

The shift routine has conveniently left X = 8 so that the byte pointer in R8 addresses the byte the cursor is pointing to. What could be easier?

The three controls, CR, LF and FF, are quite obvious. I do not need to make any further remarks on their behalf, except to note that they must dump the back-space stack. This is nothing more than initializing the stack pointer to "empty" and storing the current bit pointer in its top.

The scrolling routine is also easy to understand. Rather than arbitrarily rolling up six pixels, I decided it was no extra effort to roll up by exactly the amount of the overshoot. This is of no particular value in this program, but the Netronics Tiny BASIC supports a PLOT command, so the overshoot may be as little as a one pixel row. The intelligent scrolling thus preserves the most possible out of this tiny display.

The loop that actually moves the buffer data up has one subtlety: It checks for the end of the buffer by subtracting the ending address. This is the end of the display area, but future overflows will probably store characters in the overflow area, so it must be cleared (particularly to remove whatever pieces of debris might have been left there by the character that overflowed this time). I could have done this with a separate loop, but most of what I want is already in the loop just finished.

So the accumulator is set to zero, and if we have not yet reached the end of the overflow area, the loop is repeated. That zero will be stored, then the original loop will exit again on overflow, allowing us to force another zero through in this strange anti-loop.

I think by now you should not have much trouble understanding the back-space routine. If the stacked bit pointer is greater than the current, the character to be erased is split over two words. The current word is completely cleared by storing zero in it.

Here it might have been nice to get the counting subroutine without the shift routine, but a zero shift is not very costly. Then, or otherwise, the stacked bit pointer is used as a shift count.

I allow for the possibility that the stack overran the display area and was clobbered by a scrolling operation. In such a case the back space will be some random amount, but this is a localized problem which goes away as soon as the user returns to proper use of carriage returns and whatnot.

The ANI 7 instruction ensures that the possible trash popped out of the stack is in the correct form and will not have adverse consequences. For this part of the erase operation, a mask byte is shifted right by the appropriate amount. This puts zeros where we really want ones and ones where we want zeros, but

```
0435 B4B454;                    ,#B4B454
0438 00DFA5DF8080;              ,#00DFA5DF8080
043E 35553A00;                  ,#35553A00
0442 0056AAAB0000;              ,#0056AAAB0000
0448 000000000000;              ,#000000000000
044E ;                 ..
044E ;                 ..  MEMORY ALLOCATIONS (BUFFERS)
044E ;                 ..
044E ;                 BSTK= *
044E ;                      PAGE
0500 ;                      ORG *-80
04B0 ;                 BUFF= *
04B0 ;                      ORG *+40
04D8 ;                 HOME= *
04D8 ;                      ORG *+304
0608 ;                 BUFE= *
0608 ;                      ORG *+56
0640 ;                 BUFX= *
0640 ;                 ..
0640 ;                 ..  MEMORY ALLOCATIONS (PAGE 00)
0640 ;                 ..
0640 ;                      ORG 8
0008 000000;           TVXY: ,0,0,0        .. CURRENT CURSER POSITION
000B 00;               PSTK: ,0            .. POINTER TO BACKSPACE STA
000C 00;               MASK: ,0            .. TEMP
000D 000000;           TIME: ,0,0,0        .. REAL TIME CLOCK
0010 ;                 ..
0010 ;                 ..  LOCATIONS DEFINED IN TINY
0010 ;                 ..
0010 ;                      ORG 19
0013 7F;               BS:   ,127          .. BACKSPACE = DEL
0014 1B;               CANC: ,27           .. CANCEL = ESC
0015 ;                 ..
0015 ;                 ..  TEST MAIN
0015 ;                 ..
0015 ;                      ORG #20
0020 90;               TEST: GHI 0         .. INITIALIZE REGISTERS
0021 B3;                     PHI 3
0022 B4;                     PHI 4
0023 B5;                     PHI 5
0024 B7;                     PHI 7
0025 BD;                     PHI PZ
0026 F80F;                   LDI #0F
0028 B2;                     PHI 2
0029 A2;                     PLO 2
002A F837;                   LDI MAIN
002C A3;                     PLO 3
002D F847;                   LDI CALL
002F A4;                     PLO 4
0030 F859;                   LDI RETN
0032 A5;                     PLO 5
0033 F868;                   LDI GETZ
0035 A7;                     PLO 7
0036 D3;                     SEP 3         .. GET OUT OF P=0
0037 F80C;             MAIN: LDI 12        .. CLEAR SCREEN
0039 D400DF;                 SEP 4,A(TVD)  .. BY OUTPUTTING FORMFEED
003C F80A;                   LDI 10        .. THEN LINEFEED
003E D400DF;                 SEP 4,A(TVD)
0041 D400B7;           REPT: SEP 4,A(KEYN) .. INPUT & ECHO CHARACTER
0044 3041;                   BR REPT       .. LOOP FOREVER
0046 ;                 ..
0046 ;                 ..  UTILITY ROUTINES
0046 ;                 ..
0046 D3;                     SEP 3
0047 BF;               CALL: PHI X         .. SAVE ACC
0048 E2;                     SEX 2         .. PUSH R3
0049 86;                     GLO 6
004A 73;                     STXD
004B 96;                     GHI 6
004C 73;                     STXD
004D 83;                     GLO 3
004E A6;                     PLO 6
004F 93;                     GHI 3
0050 B6;                     PHI 6
0051 46;                     LDA 6         .. GET SUBROUTINE ADDRESS
0052 B3;                     PHI 3
0053 46;                     LDA 6
0054 A3;                     PLO 3
0055 9F;                     GHI X         .. RECOVER ACC
0056 3046;                   BR CALL-1     .. AND EXIT
0058 ;                 ..
0058 D3;                     SEP 3
0059 BF;               RETN: PHI X         .. SAVE ACC
005A 96;                     GHI 6         .. POP R3 OFF STACK
005B B3;                     PHI 3
005C 86;                     GLO 6
005D A3;                     PLO 3
005E 12;                     INC 2
005F 42;                     LDA 2
0060 B6;                     PHI 6
0061 E2;                     SEX 2
0062 F0;                     LDX
0063 A6;                     PLO 6
0064 9F;                     GHI X         .. RECOVER ACC
0065 3058;                   BR RETN-1     .. AND EXIT
0067 ;                 ..
0067 D3;                     SEP 3
0068 43;               GETZ: LDA 3         .. GET ADDRESS
0069 AD;                     PLO PZ
006A ED;                     SEX PZ
006B 4D;                     LDA PZ        .. GET DATUM
006C 3067;                   BR GETZ-1
006E ;                 ..
:
```

that is easily fixed.

Display Characters

Indexing into the pointer table is accomplished by doubling (shifting left) the character code and adding it to the start of the table less 64. This is because the first entry in the table has an ASCII code of 32 (hex 20).

The first byte of the selected table entry is saved in the page 00 memory location labeled MASK (address 000C in this program). The FECH pseudo-op sets the register RD to point to the location after the address in its call (this is the way it is in Tiny BASIC; usually I write the FECH routine with an LDN rather than an LDA), which explains the apparent discrepancy in addressing. The dot table offset is added to the address of the beginning of the dot table, and the sum is left in RF.

Other operations performed in setting up the character transfer include shifting the bit mask using (what else?) the shift co-routine. This requires the use of R9, so the cursor position already there is saved in the processor stack (R2).

The low three bits of the mask byte are the position count, which becomes the shift count (shifting right because the mask is already left-justified). The high five bits are that mask. Finally, the difference between the positions of the character in the dot table and its destination in the display buffer is computed; the result becomes the relative shift of the character in the transfer.

The actual transfer is now quite simple. A byte is fetched from the dot table (with auto-increment, another one of those nifty little features of the 1802!) and masked out to remove the bits that are not part of this character. One co-call shifts it left or right into position, so it can be ORed into the buffer; the second co-call moves the buffer pointer and, as I remarked previously, returns the loop status in the carry. The loop is repeated until the carry is zero.

If shifting the mask loses no bits off the right, we are done; otherwise, the character is split so the other half of it must be

stored. This is reasonably obvious code. If the character is being split over a line break (i.e., the address of the next byte is exactly divisible by 8 or its low three bits are 000), then the byte pointer must be moved down five more pixel rows.

The mop-up operation at the end is also reasonably clear. Here, too, is the possibility that the advance to the next word may cross over into the next line. In this case, however, we note that it takes a couple less bytes of code to use the existing subroutine to move the byte pointer down five rows. This is exactly the result of the sixth call to the counting routine. A desirable side effect is that the bit pointer is left equal to zero, so that becomes the new cursor position.

Well, there you have it. I suspect it will take you a while to digest all the tricks and subtleties of this program. I will not apologize for the program listing. It has fewer comments than some programs I have seen, but more than others. I do not see much point in repeating in the comments what the instructions say, or in repeating comments to go with repeated code. The program does run as a stand-alone if you start execution at address 0020.

Tiny BASIC

As I said at the beginning of this article (February 1979), I wrote this program to serve as the text output for the Netronics version of Tiny BASIC. After I wrote it, however, I realized that this code in its entirety, plus Tiny BASIC, left little room in a 4K RAM for user programs. So I took out the meat ax and deleted the lowercase letters (Tiny BASIC chokes on them anyway) and removed the backspace-erase capability (sob!). If you buy the Netronics Tiny BASIC you will get this reduced text capability, but, of course, you also get the added features of cassette SAVE and LOAD, a PLOT command and so on.

Many of you have bought Tiny BASIC directly from me (or one of the distributors who buys from me). You naturally want to incorporate this display routine into your Tiny BASIC. To do this you will need to relocate it so it does not conflict with the memory Tiny BASIC occupies.

Do not change the memory page 00 addresses, though; they are in the right places for Tiny BASIC. Remove the test MAIN and the three subroutines (these are already in Tiny) and set up the character input and output jumps in 0106 and 0109 to jump to KEYN and DISP, respectively. You probably should think of some kind of break test routine, but Tiny BASIC will run OK without it. Start the program at location 0100 and go! ■

✓ Reader Service—see page 179

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Truly Random Numbers

Beat the pseudorandom-number syndrome with this generator of genuinely random numbers.

Computer programs for generating pseudorandom dom numbers use a seed number, expand and scramble it some way and truncate to get a new number that is both the pseudorandom number and the new seed. If you start with a certain number, a predictable sequence will be generated until the starting number reappears to initiate exactly the same sequence all over again. To avoid getting the exact same pattern as before, you must use different seeds or go through the sequence for a while before accepting the first number as random.

Obviously, a number cannot appear twice in a row in a sequence because it is then the seed for itself. In fact, a criterion of the quality of a pseudorandom number generator is how many numbers are in the sequence before the repeat occurs. Some tricks such as shuffling several seed numbers can help, but sequences of pseudorandom numbers obtained by software eventually repeat.

There are hardware pseudorandom number generators that use clocked shift registers to develop a scrambled sequence of numbers that gives all permutations with that number of bits and then repeats[1].

For example, a 6-bit shift register with input coded according to specified output bits will present all the numbers from 0 to 63 in an apparently random pattern. An 8-bit shift register has 256 possible numbers, but there may be disallowed states that keep producing all zeros or ones. These pseudorandom number generators from shift registers can be useful when a repeating pattern is desired, but are of little value for computer programs.

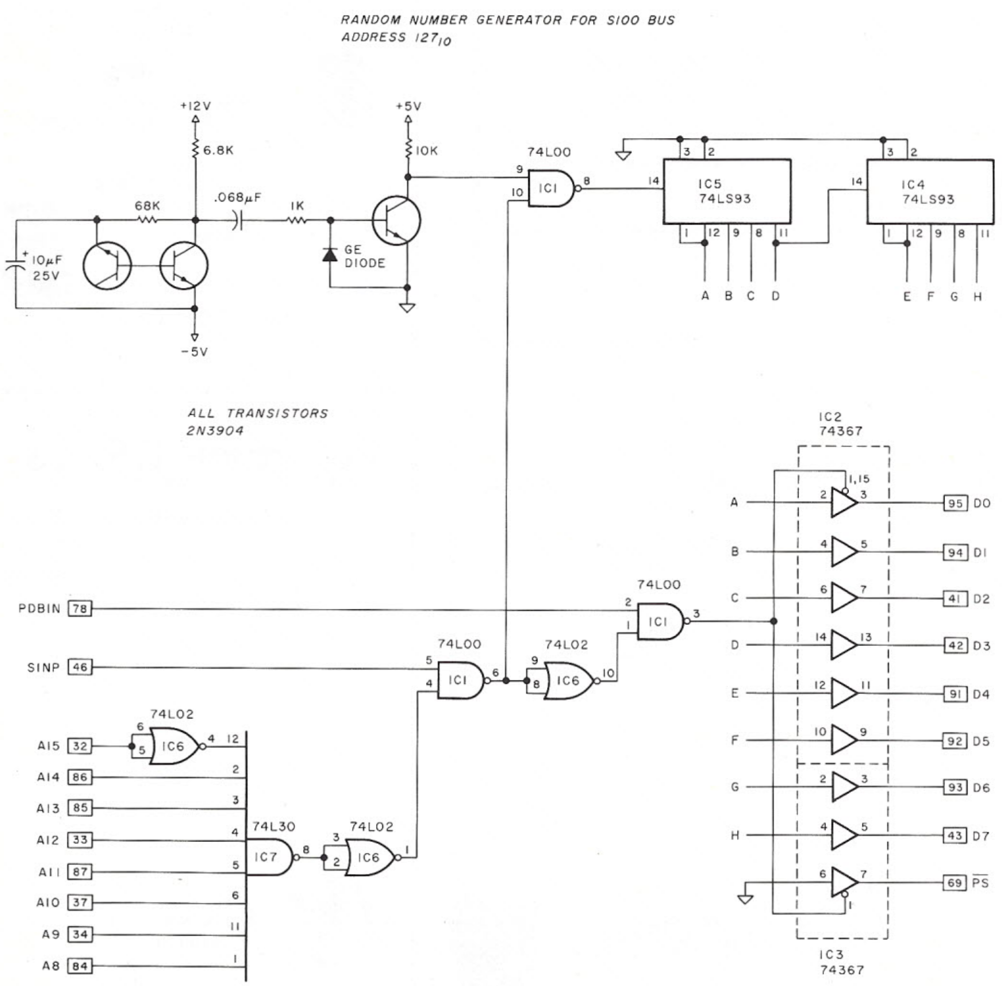

Fig. 1. Circuit schematic for random number generator.

A Truly Random Generator

For computer games and for scientific and engineering applications, truly random numbers are desirable. We have built and tested a device that plugs into the standard S-100 bus and generates random 8-bit numbers. If larger numbers are needed, these can be constructed by joining two or more 8-bit numbers. Our device is easy to build on available project boards and is suited to an advanced beginner. It uses transistors and common ICs.

Imagine a roulette wheel spinning at a fast and variable rate. If the wheel can complete

thousands of revolutions before it is suddenly stopped, the number lining up with a pointer beside the wheel will be random. Perhaps the intervals between sampling the wheel are exactly the same every time. This is where the erratic, variable spinnning rate is important because there will still be a random number.

This is the basic principle of our random number generator. A noisy, erratic clock drives a counter at a high rate giving an 8-bit number that cycles over and over through its various possiblities. If the counter is sampled at a slow rate compared to the clock rate, the result will be a random number. Even if the computer comes back to sample at a fixed interval determined by its own system clock, the faster, noisy clock of the random number generator ensures many irregular cycles of numbers before the sample.

Fig. 1 is a circuit schematic. The noisy clock consists of a transistor reverse-biased at its base-emitter breakdown potential and an amplifying transistor to increase the noise. This avalanche-breakdown method is well known for noise generation. The counter consists of two 7493 ICs. The remaining portions of the diagram are a quite ordinary address decoding circuit and a standard way of loading data lines.

In fact, if we were to start over we would use a prototype board such as the one available for $19.98 from California Digital, PO Box 3097B, Torrance CA. These boards are already etched for the decoding and data output ICs and have a kludge section for building new circuits. It would be simple to connect the noisy clock and counters.

The random number generator can easily be connected to computers with buses other than the S-100. The decoded device signal and the SINP signal (or its equivalent for another bus) are ANDed or NANDed and taken to a gate to shut off the clock signal. This latches the counter while the data signals to the Tri-state buffers are opened to the computer data lines.

The random number generator appears as I/O device 127 (decimal). To get a random number in BASIC, merely use the command:

X = INP (127)

The computer signals stop the clock and put the number on the data lines. Dividing X by 255 gives numbers between 0 and 1.

In an earlier design we combined the concept of a noisy clock with a shift-register type of sequence generator. This worked quite nicely and might be superior to the simple counter if the random number generator were to be sampled at higher speed. However, BASIC is slow and, with a short program to evaluate the random number generators, no differences were observed. As the shift-register system required more ICs and needed a trick to avoid a disallowed state, our final design presented here uses the simple counter.

Testing

To evaluate the random number generator, we sampled it many thousands of times and sorted the numbers. The occurrences of individual numbers were well balanced and no biases were observed. In a series of tests, no numbers were consistently high or consistently low in frequency of appearance. Occasionally, a number repeats, which is a good indication that all numbers have an equal probability of following a given number.

This random number generator can improve serious computation and add to the enjoyment of computer games. You no longer can be cheated by someone who has memorized the sequence of pseudorandom numbers or knows the bias of the random number program. ■

1. Don Lancaster, *TTL Cookbook*, p. 279, H. W. Sams & Co. (1975).

SWTP CT-1024 Mod

Stop "runaway" regulators in the CT-1024 Video Terminal with this easy modification.

Glen A. Deibert
431 Dunmore Rd.
Fayetteville NC 28303

The SWTP CT-1024 Video Terminal has a potential disaster built into it. The P197 power supply provides the ± 5 volts and the 12 volts to operate the terminal. The + 5 volts to all the CT-1024 logic circuitry is regulated by a series pass transistor (MJE3055). The input to this transistor is about 10 V dc, and the output is 5 V dc at 2.5 Amps.

The output of the MJE3055 is held at 5 V dc by the two transistors Q1 and Q2 and zener diode D8. If the zener diode fails, the emitter of Q1 can become grounded, which will instantly cause the output of the MJE3055 to approach the input voltage.

This happened twice during construction of my CT-1024, but I caught it before I connected the power plug to the main chassis. Why the diodes failed, I can't say. Since that day, I have been living with a potential catastrophe, waiting for D8 to fail again.

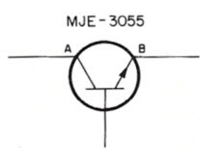

Fig. 1. CT-1024 5 volt regulator.

The CT-1024 can be easily modified to eliminate the potential damage caused by a "runaway" regulator. Replace all 13 components of the present 5 V dc regulator with an LM323K. The LM323K regulator is simply put in place of the MJE3055. Connect a wire to what was the MJE3055 collector connection on the PC board and run it to the input of the LM323. Connect the output of the LM323 to the terminal on the PC board where the emitter of the MJE3055 was connected. The LM323 should be installed on a heat sink.

This modification will provide a voltage regulator that has thermal and over-current protection and is blowout-proof. ■

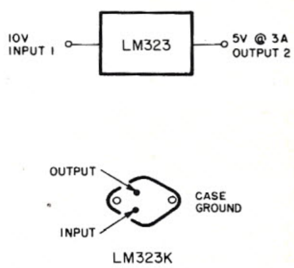

Fig. 2. Modification.

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Who Sells Software?

A big, good question. Here's a good, comprehensive answer.

Here is a partial list of companies and individuals who produce or sell software; equipment manufacturers are not listed since often their software will run only on their own products. I have also tried to list only the original sources, rather than dealers. This is, though, not always possible, and it is likely that the same program may be available from more than one source.

Apple II Software

Creative Computing Software, PO Box 789, Morristown NJ 07960.

Nelson Capes, 586 Kent Lane, Shoreview MN 55112, games.

Engel Enterprises, PO Box 16612, Tampa FL 33687, educational.

GRT Corp., 12866 North Lawrence Station Rd., Sunnyvale CA 94086.

George W. Lee, 18803 St. Christina Ave., Cerritos CA 90701, games.

Magnemedia, 17845 Sky Park Circle, Irvine CA 92714, games and educational.

Micro Users Software Exchange, PO Box 13365, Baltimore MD 21203, games and graphics.

C. W. Moser, 3239 Linda Drive, Winston-Salem NC 27106, assembler and text editor.

SubLogic, PO Box 3442, Culver City CA 90230, graphics.

Speakeasy Software Ltd., Box 1220, Kemptville, Ontario, Canada K0G 1J0, assorted.

The 6502 Software Exchange, 2920 Moana, Reno NV 89509.

Softape Software Exchange, 10756 Vanowen, North Hollywood CA 91605.

KIM-1 Software

H & A, PO Box 158, Clarksburg MD 20734, utilities.

C. W. Moser, 3239 Linda Dr., Winston-Salem NC 27106, utilities.

The 6502 Software Exchange, 2920 Moana, Reno NV 89509.

PET Software

Don Alam Enterprises, PO Box 401, Marlton NJ 08053, games.

Aresco, Box 43, Audubon PA 19407.

Computers One, 306 Kahala Office Tower, 4211 Waialae Avenue, Honolulu HI 96816, business and home.

Cursor, Box 550, Goleta CA 93017, magazine.

Creative Computing Software, PO Box 789, Morristown NJ 07960.

Connecticut microComputer, 150 Pocono Road, Brookfield CT 06804, word processing.

Eclectic Corp., 2830 Walnut Hill Lane, Dallas TX 75229, games.

Engel Enterprises, PO Box 16612, Tampa FL 33687, educational.

GRT Corp., 12866 North Lawrence Station Rd., Sunnyvale CA 94086.

Instant Software, Inc., Peterborough NH 03458, assorted programs.

Richard Liebert, PO Box 268, Scarborough Station NY 10510, games.

Magnemedia, 17845 Sky Park Circle, Irvine CA 92714, games and educational.

Microtronics, 5943 Pioneer Road, Hughson CA 95326, Morse code hardware and software.

The Microcomputer Resource Center, 1929 Northport Dr., Room 6, Madison WI 53704, PET cassette exchange.

National Corporate Sciences, Inc., 790 Madison Avenue, New York NY 10021, financial.

Peninsula School Computer Project, Peninsula School, Peninsula Way, Menlo Park CA 94025, games.

PET-Shack Software House, Marketing and Research Co., PO Box 966, Mishawaka IN 46544.

The PET User Group, Box 371, Montgomeryville PA 18936.

Personal Software, PO Box 136, Cambridge MA 02138, games and finance.

Reich Engineering, 635 Giannini Drive, Santa Clara CA, games, PET.

C. M. Stuart, 5115 Menefee Dr., Dallas TX 75227.

Softbyte, 315 Dominion Dr., Newport News VA 23602, income tax.

Speakeasy Software Ltd., Box 1220, Kemptville, Ontario, Canada K0G 1J0, assorted.

Softape Software Exchange, 10756 Vanowen, North Hollywood CA 91605.

TRS-80 Software

Apparat, Inc., Box 10324, Denver CO 80210, games and financial.

The Bottom Shelf, Inc., PO Box 49104, Atlanta GA 30359, games and educational.

Jim Creasy, 517 Reeves Drive, Phoenixville PA 19460, educational games.

Computers One, 306 Kahala Office Tower, 4211 Waialae Avenue, Honolulu HI 96816, business and home.

Circle Enterprises, Box 546, Groton CT 06340, games and business.

Creative Computing Software, PO Box 789, Morristown NJ 07960.

Jim Clayton, 3520 S.E. Vineyard Road, Milwaukie OR 97222.

Don Coon, 1228 Alpine, DeWitt MI 48820, text editing.

Computer Information Exchange, Box 158, San Luis Rey CA 92068, newsletter.

B. Erickson, PO Box 11099, Chicago IL 60611, games.

EMFW, Box 438, Oakhurst NJ 07755.

Engel Enterprises, PO Box 16612, Tampa FL 33687, games.

Ess too—Dee too Products, PO Box 6128, Shreveport LA 71106, games.

J. Fox, 27 Prince Wm. Road, Morganville NJ 07751, games, small business.

GRT Corp., 12866 North Lawrence Station Rd., Sunnyvale CA 94086.

Don Groves, 1101 S. 2nd Avenue, Marshalltown IA 50158.

Dr. S. Harter, Box 17222, Tampa FL 33682.

G. Frank Humiston, 506 Wayne Avenue, El Cajon CA 92021.

J. and J. Hansen, 6890 50 Street, San Diego CA 92120, electronics design.

Instant Software, Inc., Peterborough NH 03458, assorted programs.

Interactive Microware, Inc., 116 S. Pugh Street, State College PA 16801, games.

J. Joyce, 5925 Rockhill Rd., Kansas City MO 64110, games.

C. Jones, 658 Edinboro Rd. NW, Atlanta GA 30327, business and accounting.

Jensen, 1589 Blossom Park, Lakewood OH 44107, games.

Level IV, 32030 Cheboygan, Westland MI 48185, business and games.

Bill Lanke, RR 51, Box 533, Terre Haute IN 47805, games.

R. Menzies, 7106 Colgate Drive, Alexandria VA 22307, games.

Magnemedia, 17845 Sky Park Circle, Irvine CA 92714, games and educational.

Miller Microcomputer Services, 61 Lakeshore Rd., Natick MA 01760.

L. Owens, Rt. 6 Box 336, Thomasville GA 31792, small business.

Poi Pow, 96 Dothan Street, Arlington MA 02174.

D. Palmer, 815 Ky Avenue, Lynn Haven FL 32444, music.

Gene Perkins, 5224 Winifred, Ft. Worth TX 75227, utilities.

PET-Shack Software House, Marketing and Research Co., PO Box 966, Mishawaka IN 46544.

Project TRS-80, PO Box 122, Blacksburg VA 24060.

Personal Software, PO Box 136, Cambridge MA 02138, games and finance.

Tim Quinlan, 219 Washington Ave., Chelsea MA 02150, games.

J. Quistgaard, 715 S. Alder Street, Port Angeles WA 98362, games.

Rupert Corp., 6701 Simms Street, Hollywood FL 33024, games.

Small System Software, PO Box 483, Newbury Park CA 91320, games, etc.

Sandy Sigal, 6851 Mammoth Avenue, Van Nuys CA 91405, games.

Sunset EDP Service, PO Box 80683, Lincoln NB 68501, games.

Softbyte, 315 Dominion Dr., Newport News VA 23602, income tax.

Speakeasy Software Ltd., Box 1220, Kemptville, Ontario, Canada K0G 1J0, assorted.

Softape Software Exchange, 10756 Vanowen, North Hollywood CA 91605.

TapeTalk, PO Box 54014, San Jose CA 95154.

The TRS-80 Software Exchange, 17 Briar Cliff Drive, Milford NH 03055, business and games.

Robert L. Trenor, 4113 Ohio Ave., Tampa FL 33616, home finance.

TRS-80 Monthly Newsletter, PO Box Q, Philadelphia PA 19105, assorted.

TRS-80 Program Exchange, 4418 Morrow Road, Modesto CA 95359, assorted.

Web Associates, Box 60, Monrovia CA 91016.

C. Zalnerunas, 3034 W. Columbus Ave., Chicago IL 60652, games.

Software for Other Systems

AlphaBIT Microsystems, 2000 Center Street, Berkeley CA 94704, Z-80.

Administrative Systems, Inc., 222 Milwaukee, Suite 102, Denver CO 80206, business.

Advanced Interactive Systems, 8216 Pickering Street, Philadelphia PA 19150, Poly-88 utilities.

AJA Software, PO Box 2528, Orange CA 92669, North Star.

Alpha Data Systems, Box 267, Santa Barbara CA 93102, North Star.

Michael Albaneze, 102 Oceanview Avenue, Staten Island NY 10308, bowling league programs.

Arjay Enterprises, PO Box 8813, San Marino CA 91108, Xitan utilities and games.

Aresco, Box 43, Audubon PA 19407, COSMAC VIP.

The Amador Group, PO Box 2032, Menlo Park CA 94025, SWTP.

Allen Ashley, 395 Sierra Madre Villa, Pasadena CA 91107, North Star, 8080/Z-80.

Roger Buck, 1122 Post Dr., Rockford IL 61108, North Star.

Gary Bedrosian, 3412 Alma Ave., Manhattan Beach Ca 90266, games.

Byte Shop of Berkeley, 1514 University Avenue, Berkeley CA 94703, business.

Benson & Costello, 2902 23 Avenue, Astoria NY 11105, business, North Star.

Business Computer Systems, 216 Collier Drive, Springfield IL 62704, business, North Star.

Computerware Software Services, 830 First Street, Encinitas CA 92024, SWTP.

Computer Mart of New Jersey, 501 Route 27, Iselin NJ 08830, CP/M, ICOM and Micropolis.

Computer Systems Design, 1611 E. Central, Wichita KS 67214, North Star.

CHROMOD Associates, PO Box 3169, Grand Central Station, New York NY 10017, utilities.

Computertex, 2300 Richmond, Houston TX 77098, business, North Star.

Compumax Associates, 505 Hamilton Ave. Suite 306, Palo Alto CA 94301, business.

The Computerist, PO Box 3, So. Chelmsford MA 01824, 6502.

Creative Computing Software, PO Box 789, Morristown NJ 07960, SOL-20.

Computer Information Exchange, Box 158, San Luis Rey CA 92068, word processing.

The Computer Port, 926 North Collins, Arlington TX 76011, SOL-20.

The Computer Mart, 1800 W. 14 Mile Road, Royal Oak MI 48073, business, North Star.

Computer Systems Design, 1611 E. Central, Wichita KS 67214, North Star.

J. Dvorak, 704 Solano Avenue, Albany CA 94706, North Star.

The DG User's Group, PO Box 316, Woodmere NY 11598, Digital Group.

Data Mini Systems Corp., 199 East 58 Street, New York NY 10022, business.

The Digital Deli, 80 W. El Camino Real, Mountain View CA 94041, disk utilities, North Star.

Digital Research, PO Box 579, Pacific Grove CA 93950, CP/M operating system.

Engel Enterprises, PO Box 16612, Tampa FL 33687, educational, North Star.

Engram Associates, Inc., PO Box 9885, Little Rock AR 72219, business.

Bob Fabris, 3626 Morris Drive, San Jose CA 95127, Bally users' group.

Golden State Software, Box 358, Pompton Lakes NJ 07058, 6800.

GRT Corp., 12866 North Lawrence Station Rd., Sunnyvale CA 94086.

J. T. Howson, 35 Briarwood Lane, Marlboro MA 01752, North Star utilities.

Gill House, PO Box 158, Clarksburg MD 20734, utilities, 6502.

Hemenway Associates, Inc., 151 Tremont Street, Suite 8P, Boston MA 02111, advanced utilities, SWTP.

HSC Computer Services, PO Box 43, Brooklyn NY 11236, business, North Star.

Infinite, Inc., 1924 Waverly Place, Melbourne FL 32901, 1802.

Information Unlimited, 331 W. 75 Pl., Merrillville IN 46410, business for CP/M.

Interactive Microware, Inc., 116 S. Pugh Street, State College PA 16801, utilities, 8080.

Intec, 408 Sugarland Run Drive, Sterling VA 22170, home and business.

Interactive Data Systems, PO Box 290, Owings Mills MD 21117, utilities and games, Mits BASIC.

Johnson Computer, PO Box 523, Medina OH 44256, 6502.

Patrick Kelly, PO Box 7162, Los Angeles CA 90022, COSMAC 1802.

Bob Kelly, 2622 Miramar Avenue, Castro Valley CA 94546, games, North Star.

Lifeboat Associates, 164 West 83 Street, New York NY 10024, disk utilities, Micropolis and North Star.

Lombardi Electronics, 110 Ludwig Rd., New Castle PA 16105, billing, letter writing, games.

Microware Systems Corporation, PO Box 954, Des Moines IA 50304, utilities, 6800.

Micro Logistics, PO Box 922, Madison Square Station, New York NY 10010, utilities, North Star.

Microcomputer Resources, Inc., 3000 Medical Park Drive, Tampa FL 33612, Processor Technology.

Micro-Ap, 8939 San Ramon Rd., Dublin CA 94566, business, Microsoft Disk BASIC.

Stephen Moe Co., PO Box 595, Springfield OR 97477, business, SWTP.

Micro Computers of New Orleans, Inc., 2025 Canal Street, New Orleans LA 70119, games and business.

Mobius, Inc., 300 Clifton Ave. Suite 205, Minneapolis MN 55403, business, North Star.

Micro Software Specialists, Inc., Box 2034, Marshall TX 75670, assembler, 6502.

Microlithics, Inc., 2918 N. MacArthur Blvd., Oklahoma City OK 73127, Z-80.

Paul C. Moews, 39 Mansfield Apts., Storrs CT 06268, utilities and games, COSMAC Elf.

C. W. Moser, 3239 Linda Dr., Winston-Salem NC 27106, utilities, 6502.

Newby Software Development Co., 299 Dawlish Avenue, Toronto, Ontario, Canada M4N 1J6, budget and games, SOL-20.

Ohio Micro Systems, 233 South Water Street, Kent OH 44240, text editing and income tax, North Star.

Osborne & Associates, Inc., PO Box 2036, Berkeley CA 94702, many good books.

R. E. Penley, 3578 Kelly Circle, Bolling AFB DC 20336, ICOM.

Pete Pacione, 2952 N. Meade, Chicago IL 60634, games and utilities, SOL-20.

Programma Consultants, PO Box 70127, Los Angeles CA 90070, utilities, 6800.

Rothenberg Information Systems, 206 Sheridan Ave., Palo Alto CA 94306, utilities, CP/M.

RLM Associates, 1077 Ticonderoga Dr., Sunnyvale CA 94087, utilities.

Herbert Schildt, 1007 N. Division, Urbana IL 61801, games and home finance, North Star.

Software Records, PO Box 8401, Universal City CA 91608, games and graphics.

Ed Smith's Software Works, PO Box 339, Redondo Beach CA 90277, utilities, 6800.

Scientific Research, PO Box 490099, Key Biscayne FL 33149, large variety, mostly BASIC.

Scelbi Computer Consulting, Inc., PO Box 133, Milford CT 06460, assorted, 8080 and 6800.

Raymond Schreiner, 391 Broadway, Bayonne NJ 07002, Compucolor 8001.

Synchro-Sound Enterprises, 193-25 Jamaica Avenue, Jamaica NY 11423, 8080 and Z-80, business.

Software, Box AF, Woodbridge CT 06525, North Star, business.

Michael Shrayer Software, 1235 Vista Superba Dr., Glendale CA 91205, text editing.

Sunshine Computer Co., 20710 Leapwood Ave., Carson CA 90746, North Star, business.

Structured Systems Group, 5625 Kales Avenue, Oakland CA 94618, business.

The Software Store, 706 Chippewa Square, Marquette MI 49855, utilities and business.

Surf Computer Services, PO Box 66572, Los Angeles CA 90066, North Star.

The 6502 Software Exchange, 2920 Moana, Reno NV 89509.

The Software Works, Inc., Box 4386, Mountain View CA 94040, North Star, business.

Supersoft, PO Box 1628, Champaign IL 61820, North Star.

Softape Software Exchange, 10756 Vanowen, North Hollywood CA 91605, North Star.

TSA Software, 5 North Salem Road, Ridgefield CT 06877, 8080 and Z-80.

Tylog Systems, 9805 S. W. 152 Terrace, Miami FL 33157.

Tiny c associates, PO Box 269, Holmdel NJ 07733, 8080 and PDP-11.

Technical Systems Consultants, PO Box 2574, West Lafayette IN 47906, 6800 and 8080.

United Software Applications, 342 Columbus Avenue, Trenton NJ 08629, games and business.

Vanguard Systems Corp., 6812 San Pedro, San Antonio TX 78216, Z-80.

Wintek Corp., 902 North 9 Street, Lafayette IN 47904, 6800.

Williams TV, Inc., 2062 Liberty Street, Jacksonville FL 32206, North Star.

R. Weisling, 25252 Fort Road, Newhall CA 91321.

Software Directories

Excellent directories of available software are also published by the following:

Robert E. Purser, PO Box 466, Eldorado CA 95623.

Schreier Software Index, 4327 East Grove Street, Phoenix AZ 85040.

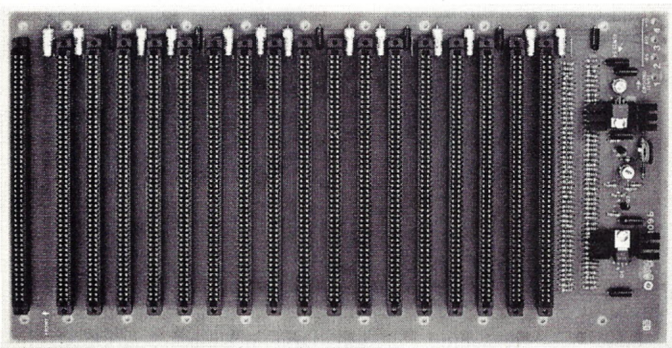
See also the ads appearing *Kilobaud MICROCOMPUTING* every month. ■

Reader Service—see page 179

Craig Anderton
c/o Kilobaud Editorial Dept.

How Important Is Proper Termination?

An ounce of prevention is worth a pound of cure—especially in the field of microcomputing. With Godbout's motherboard you can prevent annoying glitches before they happen.



Godbout motherboard.

A motherboard is not a particularly glamorous piece of equipment; its function in life is simply to hold a lot of computer cards (CPU, memories, I/O boards, etc.) in its edge connectors. Since compatible computer boards share a common bus scheme, the various edge connectors are paralleled together; thus, plugging in a card connects it with all the other cards.

Since I do not yet have a computer system, building a motherboard seemed like a good place to start—I could follow up with a power supply, memory card, then some kind of CPU and front panel—and I'd have a working computer.

I decided on a Godbout motherboard (these boards use the S-100 bus scheme originated by Mits for their Altair 8800 microcomputer) for a simple reason: I'm involved in doing some of Godbout's graphics and got a discount I couldn't refuse. The regular price of the 10-slot motherboard is $90, although there is also an 18-slot version for $124. This review will concentrate on the 10-slot version.

As you read this, there is one point to remember: I am a complete computer novice. I have been working with electronics for years; but my work has all been in the field of musical (mostly analog) electronics, which is a very different animal.

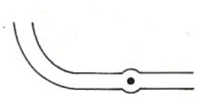
Kit Description

Upon opening the box and removing the contents, you will find a big (8½ x 11 inches) circuit board, a bag of electronic components, ten edge connectors and instructions. The board itself is 1/16 inch epoxy glass, single sided, with screened legends on the component side for unambiguous parts placement. To simplify soldering around some of the tighter parts traces, there is a soldermask, which effectively prevents solder from flowing accidentally to a neighboring trace. This is a nice feature, but it takes a little getting used to. The various electronic components form the basis of an active terminating network, which we will discuss later.

Soldering with a Soldermask Board

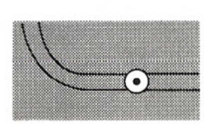
In case you are not familiar with this type of board, it is a regular PC board that is screened with a solder-resistant coating on the foil side. This mask is screened over the entire board, except where there are solder connections to be made (see Figs. 1a and 1b). Thus, solder does not run down a trace but adheres to the junction of exposed board and exposed lead. Soldering, therefore, requires care, since trying to force lots of solder onto this type of joint will make it ball up around the lead. On the other hand, since solder does not comfortably hold or flow over the solder resist, the chance of getting a bridge between tight, adjacent traces decidedly is minimized.

The best way to solder with this type of board is to keep the component leads straight up at all times, not bent over as on other types of boards (see Fig. 2). At this point, you might wonder, how do you keep the components from falling out when you flip the board over to solder? Well, the instructions recommend an order of assembly, based on the height of components, whereby you flip the board over onto a table, book or other flat surface, thus



DETAIL OF UNMASKED CIRCUIT BOARD TRACE. A SOLDER TIN PLATE OVER THE COPPER PREVENTS TARNISH OR OXIDATION AND PROVIDES FOR BETTER SOLDERING.

(a)



SOLDER MASK SCREENS OVER EVERYTHING *EXCEPT* AREA ADJACENT TO HOLE.

(b)

Fig. 1.

pushing the parts against the component side of the board. You may then solder without being the victim of "fallout."

When soldering, bring the tip in at an angle, against the board pad and component lead; then feed in a tiny bit of solder at opposite ends of the lead (see Fig. 3). This makes for a solid joint with no excess solder.

It may seem elementary to discuss soldering in such detail, but most of the repairs that kit companies have to suffer through involve bad soldering. Sure, there are defective ICs in kits from time to time; but bad solder jobs account for the majority of nonfunctioning units. This is true for almost any kind of electronic kit, not just computer kits. However, because of the tight traces and tolerances, proper soldering of computer kits—especially those using the S-100 bus—is even more important.

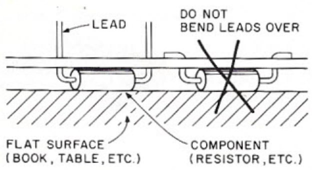


Fig. 2.

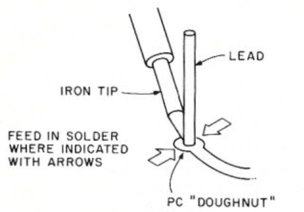


Fig. 3.

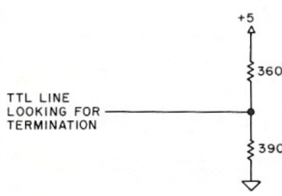


Fig. 4.

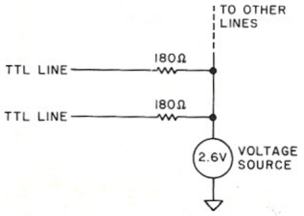


Fig. 5.

Construction

It took me about 3½ hours to mount and solder all components on the board. This may seem slow, but I methodically, patiently soldered the edge connectors and components. Not only did I want the thing to look good, I also wanted it to be reliable and work the first time.

After construction, I double-checked the board with a magnifying glass and applied power according to the power-up instructions. I calibrated the active termination circuitry as specified (this test requires either a dc voltmeter or dc reading scope; you measure across a test point and adjust the board's trimpot for a 2.6 V reading).

What's This Active Termination Jazz, Anyway?

I posed this question to Bill Godbout, since I couldn't figure out exactly what was going on myself, and received an interesting lesson on TTL termination.

The standard TTL termination is a passive 2.6 V reference, composed of a 360 Ohm and 390 Ohm resistor in series across the power supply (see Fig. 4). This allows for proper sourcing and sinking of the TTL line connected to its midpoint, and keeps the impedance down to minimize pickup of noise and crosstalk. Each of these terminations, however, also draws about 6.7 mA from the power supply. So, terminating 94 lines in this manner means a standby current drain through the terminators of well over half an Amp! These passive terminations don't just put a strain on your power supply, they waste energy and create heat inside your computer's enclosure. I don't think we have to go much further to realize that passive termination is not such a good way to do things, although it's better than no termination at all.

The active termination in the Godbout motherboard takes advantage of the existence of an equivalent *active* structure, based around a voltage source and isolating resistor, that can accomplish the same results (Fig. 5). Current can either source or sink through the 180 Ohm resistor, either dumping into or drawing from the voltage source. Terminating more lines simply means adding more 180 Ohm resistors between the line and voltage source.

As a result, the standby current is slashed to the standby current of the voltage source circuitry—about 15 or 20 mA—quite a savings in energy. In practice, the Godbout motherboard uses 270 Ohm terminating resistors to accommodate boards that can't drive a 180 Ohm load. However, all Godbout peripherals can drive 180 Ohms—if you have an all-Godbout system and want even lower impedance, you can use 180 Ohm instead of 270 Ohm resistors.

The current drain increases as lines require sourcing or sinking, but here we are somewhat fortunate. At any given moment, on 94 lines there will be a nearly equal mix of 1s and 0s. This tends to cancel out and, thus, reduce the current drive requirements of the voltage source. Nonetheless, although this keeps average current consumption down, there are instances when you might have an extreme momentary need for current. As a result, the voltage source has enough capacity built in to take care of the most extreme cases.

The structure of the voltage source is fairly simple (see Fig. 6); IC1 (a three-terminal regulator) sets up a stable voltage reference independent of master power-supply variations. IC2, a micro-power op amp, is hooked up as a simple voltage regulator with Q1-Q4 set up as current-boosting devices to cover any large current demands. R1, the trimpot, adjusts the output voltage of the op amp—hence, the terminator voltage—to 2.6 volts.

If you have a 5 V regulated supply for the motherboard rather than an 8 V filtered-but-unregulated supply, simply leave IC1 out of the circuit and short out its input and output pads so that R1 connects

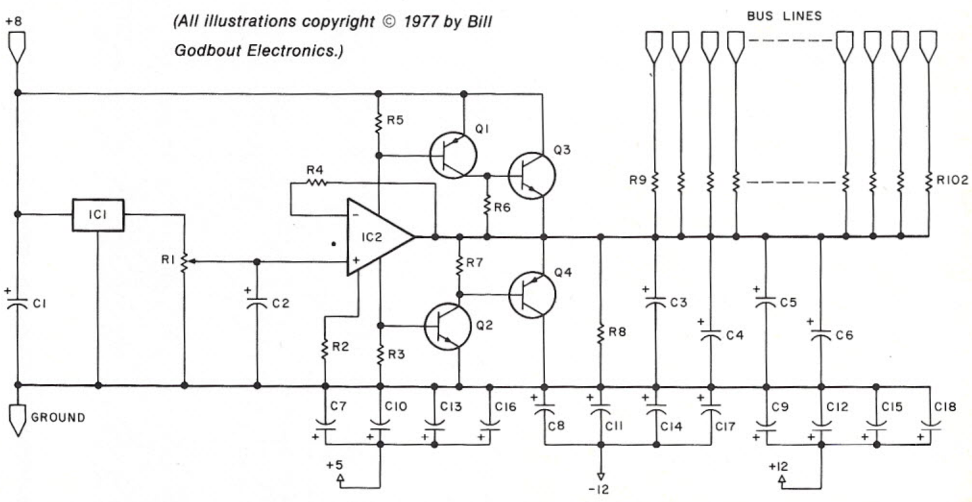


Fig. 6. Motherboard circuitry schematic.

directly to the 5 V regulated supply. Because the op amp is forced to run from ±2.5 V in this mode, you might expect some problems since a supply voltage range that low is marginal for most op amps. However, the 4250 chosen for this application can work satisfactorily down to ±1.5 V, so it's well within specifications. The only other components required on the board are several tantalum bypass capacitors.

By the way, although advertised mostly as a 10-slot motherboard, the Godbout board has an extra position for an eleventh slot. In a standalone system, you can pop in another edge connector and add another peripheral; or, you can add a jumper from this slot to a previously existing motherboard (an Imsai, for example) if you want to increase the capacity of an existing machine. In fact, the mounting holes are spaced to bolt right into a standard Imsai case.

Miscellaneous Features

The traces used to supply the various voltages to the motherboard are extra wide and heavy, and run around the outside of the board. Wire jumpers connect these heavy traces to the bus power lines. This arrangement gives greater current-handling capacity than attempting to run all power lines directly to the edge connectors without jumpers.

Another feature that makes a lot of sense is the inclusion of remote sensing points for the +5 V supply line. Regulated supplies often require a sense point for monitoring output voltage; however, in most instances these sense points are located at the output of the supply. This is acceptable unless you have fairly long power leads going to a piece of equipment like a motherboard, in which case the voltage drop through those leads can be appreciable. By sensing at the motherboard itself, you monitor the *board* voltage, not the *supply* voltage—and the board voltage is really what you want to keep at a constant 5 V.

Conclusion

So . . . now I have this nice-looking motherboard, all properly terminated and just itching for some S-100 peripherals to stuff in its little slots. I'm planning to build the rest of the system around other Godbout peripherals, and to write some more articles of this nature as I finish the various parts of the system. But if I become like any of the other computer fanatics I know, the articles may never get written. I might have to give up writing so I can have more time to play with my computer! ■

✓ Reader Service—see page 179

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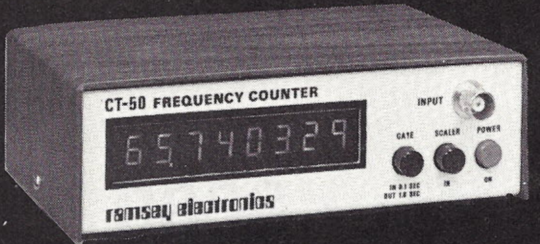

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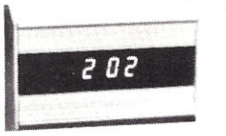

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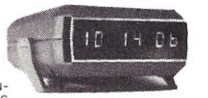

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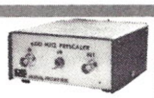

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567	1.25	7912	1.25
1458	.50	7815	.85
3900	.50	**TTL ICs**	
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✓R8

Ken Knecht
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How to Talk to Your 8080

This three-part article continues with a discussion of flags and certain instructions.

In Part 1 of this series we covered the basics of entering programs, using the front-panel switches or a monitor. Then we introduced the hex and octal numbering systems and the mysteries of split octal. We concluded with a detailed description of the commands to move data in and out of the registers and memory.

This month we'll discuss the flags (PSW register), the arithmetic instructions and the branch instructions, jump and call.

The Flags

The flags are stored in the eight bits of the PSW register. Normally we can't store data in this area, but later we will see two instructions to change one of these bits, the C (carry) bit or flag.

The 8080 takes care of setting these flags, which we will use to discover what happened in an earlier manipulation of data and perhaps determine the course the program should take depending on the condition of one or more flags. That's why we call them flags; it is as if the 8080 put up a little flag to remind us of what it did earlier.

Although there are eight flags possible, the 8080 only uses five of them:

BIT	7	6	5	4	3	2	1	0
FLAG	S	Z	X	AC	X	P	X	C

The flags labeled X are not used; this leaves us five, the S, Z, AC, P and C flags. Let's take them one at a time.

First, we'd better say—and we'll repeat this again—that move (MOV, MVI, LXI, etc.) instructions do not affect the flags in any way. If they were set earlier, they will stay set. All the flags are affected by an operation that affects the flags. So, if a flag is not set to 1 by an operation, it is changed to 0 if it was set to 1 in an earlier operation. Normally we refer to the flags after an arithmetic, rotate or comparison instruction. We will note which instructions affect the flags as we introduce them.

The S flag is used to tell us the sign of a number—if it is left at 0 after an operation, the resulting number is positive; if it is set to 1, the number is negative. So this flag might be used after a subtraction to see if the result was positive or negative or after a comparison to see which number was larger.

The Z flag tells us if the result of an operation was zero, or a positive or negative number. If the flag is at 0, then the result is *not* 0; if it is set to 1, then the result *is* 0. You'd better read that last sentence again; it can be quite confusing.

This flag is usually used after a data comparison to see if the two data bytes compared were the same. If they were the same, the result is 0 and the Z flag is set to 1. A comparison works something like subtraction, so if the bytes were equal, subtracting one from the other would result in 0 and set the Z flag to 1 to tell us so. Relax—we'll go into a lot more detail about comparisons later.

The AC flag is usually used only in the DAA instruction. It tells us if there was a carry (more later) out of bit three. This flag is referred to by the 8080. Chances are you will not have occasion to refer to it often. We will go into more detail later about the DAA instruction and the AC flag.

The P flag tells us about the parity of the result of an operation. It is not used much in general programming . . . at least in the programs I write. I don't use it in any of the examples in this series.

What it does is reflect the number of 1s in the data. If the number of 1s is even (0, 2, 4, 6, 8), then the P flag is set to 1; otherwise, it is set to 0. Perhaps you can dream up some uses for this feature. Of course it can be, and often is, used in I/O (input/output) routines if you wish to use parity check to determine the validity of the transmitted data. However, that is a bit beyond the intent of this article.

Finally, the C flag. This and the Z flag are probably the most used in general programming. The C flag is used to indicate that the result of an operation was greater than 377 octal or FF hex. If so, the carry flag is set to 1; otherwise, it is set to 0. Thus it would be used for multibyte arithmetic.

Another common use of the C flag is when rotate instructions are used. These always move one of the end bits (0 or 7) of the data into the C flag. Thus you can test a bit in the data to see if it is a 1 or 0 by checking the C flag.

Please note that there are other ways we can use these flags, too, but those mentioned are the most common usages. I'm sure you will discover many other uses as you become more proficient in programming. We might also mention that the instructions that are most used to refer to the flag conditions are the rotates, jumps and calls. We will discuss them later in this month's article.

Arithmetic Instructions

The arithmetic instructions include add, subtract, increment and decrement. Multiplication and division instructions do not exist; you must use add, subtract or some other instruction.

We'll start with subtraction. Let's say we want to subtract the contents of address 000/022 (0012 hex) from the contents of address 000/023 (0013 hex) and put the answer in 000/024 (0014 hex). The solution to this problem is shown in Program 1.

Look complicated? It's not really. We'll take them one instruction at a time. In address 000 we find an LXI,H. If you'll remember, this puts the following two bytes into register pair HL. We put the data at address 001 (022, 12 hex) in L and the data at address 002 (02 hex) (000) in H. Backwards, remember?

Next in address 003 (03 hex) we find MVI,A. This puts the following byte in A. The following byte, in address 004 (04 hex), is 005, or 5. We have stored a 5 in the accumulator (A register).

In address 005 (05 hex) we have MOV M,A. This stores the byte in A (005) into the memory location stored in HL, or 000/022 (0012 hex). We now have a 5 stored in address 000/022 (0012 hex).

We encounter a new instruction, INX,H. This means we increment register pair HL or add 1 to it. We had 000/022 (0012 hex) in HL, so we have incremented it to 000/023 (0013 hex). Thus it points to the next available open address.

Doing another MVI,A in address 007 (07 hex) and putting the 010 (08 hex) in address 010 (08 hex) in A are our next procedures. Then we move, in ad-

dress 011 (09 hex), with the MOV M,A, the 010 (08 hex), to address 000/023 (0013 hex).

That gives us 005 in address 000/022 and 010 in address 000/023. We said we wanted to subtract the contents of these two addresses and put the result in 000/024 (0014 hex). So let's do just that.

In address 012 (0A hex) we find a DCX,H. This is another new one, the opposite of INX,H. This means we subtract 1 from register pair HL. We had 000/023 (0013 hex) there so we now have 000/022 (0012 hex).

We do a MOV B,M in 013 (08 hex) to put the 005 in address 000/022 (0012 hex) in register B. In 014 (0C hex) we increment HL to 000/023 (0013 hex), and in 015 (0D hex), we do a MOV A,M to put the 010 in address 000/023 in the A register (accumulator). Then we increment HL in address 016 (0E hex) to 000/024 (0014 hex), our destination address.

A SUB,B in address 017 (0F hex) subtracts the contents of register B from the A register. Finally! This gives us 003 in the A register (010 octal minus 005 octal gives 003 octal). The number following 7 octal is 10.

We then move, in address 020 (010 hex), the contents of the accumulator to address 000/024 (0014 hex) with the MOV M,A. In address 021 (11 hex) we find the HLT, or halt command, which stops the computer.

The INX, DCX and SUB instructions affected the PSW register. In the case of the SUB, the result was not 0 so the Z flag stayed at 0. We had no borrow so the C flag stayed at 0. We had parity—we had an even number of 0s in 003—so the P flag changed to 1. We did not have a borrow out of bit 3 so the AC flag stayed at 0.

What if we just wanted to subtract two numbers? Then Program 2 would work.

We now have 003 in the A register to do with as we please. The command (instruction) in address 002 (SUI) is a new one; it means subtract the following byte, in this case 005, from the contents of the accumulator.

You will note that when an instruction ends with an I, the data follows immediately in the next byte or bytes. Thus, LXI, MVI, ADI, etc.

Addition Examples

All the ADD instructions add the contents of the named register to the accumulator and store the result in the accumulator. Thus, ADD,C means add the contents of register C to the contents of the accumulator, and ADD,M means add the contents of the memory address stored in HL (M always refers to the address in HL) to the accumulator.

The ADC commands work almost the same way. ADC,D means add the contents of register D and the contents of the carry flag (in PSW) to the accumulator. This is one way of doing a carry in addition.

Let's look at an example. We wish to add 010134 octal to 000145 octal (or 105C to 0065 hex). First we change the numbers to split octal. This makes 010134 now 020/134. And 000145 remains 000/145. Next we add the two low halves shown in Program 3a.

We have now added 134 to 145, making 477 (5C + 65 = 13F). We can't put 477 (13F hex) in one byte, so we end up with 077 (3F hex) and a carry of 1, which sets the carry flag to 1. In address 004 we move the 077 (3F hex) to register C. Now we add the two high halves of the number in Program 3b.

We put the 020 (10 hex) (one high half) in A with the MVI,A in address 005. This does not affect the carry flag, as moves do not affect the flags in the PSW register, remember? Then we put the second high half in D with address 007. Next we add with carry, register D to A, and get 021 (020 + 000 + 1); in hex it is 11 (10 + 00 + 1). We put that in register B in address 012 (0A hex) and HLT (stop computer) in address 013 (0B hex).

Now we have 021 (11 hex) in B and 077 (3F hex) in C. This is split octal. Put together, it adds up to 10477:

010134	085C
+000145	+0065
010477	113F

My point is: If we used the ADD,D instruction in address 011 (09 hex), we'd end up with 010077 (103F hex) in BC. This is the wrong sum because we didn't use the carry flag with ADC.

Eventually we'll see an easier way to do an addition of two 16-bit numbers; this gave me a

```
000   0000   LXI,H     041   21
001   0001             022   12
002   0002             000   00
003   0003   MVI,A     076   3E
004   0004             005   05
005   0005   MOV M,A   167   77
006   0006   INX,H     043   23
007   0007   MVI,A     076   3E
010   0008             010   08
011   0009   MOV M,A   167   77
012   000A   DCX,H     053   2B
013   000B   MOV B,M   106   46
014   000C   INX,H     043   23
015   000D   MOV A,M   176   7E
016   000E   INX,H     043   23
017   000F   SUB,B     220   90
020   0010   MOV M,A   167   77
021   0011   HLT       166   76
022   0012             005   05
023   0013             010   08
024   0014             003   03
```

Program 1.

```
000   00   MVI,A   076   3E
001   01           010   08
002   02   SUI     326   96
003   03           005   05
004   04   HLT     166   76
```

Program 2.

```
000   00   MVI,A     076   3E
001   01             134   5C
002   02   ADI       306   C6
003   03             145   65
004   04   MOV C,A   117   4F
```

Program 3a.

```
005   05   MVI,A     076   3E
006   06             020   10
007   07   MVI,D     026   16
010   08             000   00
011   09   ADC,D     212   8A
012   0A   MOV B,A   107   47
013   0B   HLT       166   76
```

Program 3b.

```
000   00   MVI,B   006   06   moves 100 (40 hex) to B
001   01           100   40
002   02   DCR,B   005   05   changes B to 077 (3F hex)
003   03   INR,B   004   04   changes B to 100 (40 hex)
```

Program 4.

```
000   00   MVI,C   016   0E   moves 377 (FF hex) to C
001   01           377   FF
002   02   INR,C   014   0C   changes C to 000
```

Program 5.

```
000    00    LXI,H    041    21    put split octal 020/134
001    01             134    5C    (105C hex) in HL
002    02             020    10
003    03    LXI,B    001    01    put 000/145
004    04             145    65    (0065 hex) in BC
005    05             000    00
006    06    DAD,B    011    09    the answer now in HL
007    07    HLT      166    76    stop
```

Program 6.

```
000    00    LXI,H     041    21    put 000/000 in HL
001    01              000    00
002    02              000    00
003    03    DAD,SP    071    39    add SP pair (now in HL)
004    04    MOV B,H   104    44    move H to B
005    05    MOV C,L   115    4D    move L to C
006    06    HLT       166    76    stop
```

Program 7.

```
000    00    MVI,A    076    3E    put 006 decimal in A
001    01             006    06
002    02    ADI      306    C6    add 007 decimal
003    03             007    07
004    04    DAA      047    27    answer is binary 00010011
```

Program 8.

chance to show you how the ADC command works.

The ADD series of instructions is like the SUB, only add instead of subtract. The SBB is like the ADC, except the carry bit in the PSW register now stands for a borrow instead of a carry.

The INR instructions increment the named register by 1 and the DCR decrement the named register by 1. See Program 4.

Note that 100 octal − 1 = 77 octal and 40 hex − 1 = 3F hex. There is no 99 in octal; the next lower number is 77. Note that the Z or zero flag, not the C flag, works in INR and DCR (see Program 5).

In address 002, C is 000 so the Z flag is now 1, but the C flag is still 0 . . . there is no carry in an INR instruction.

The INX increments the contents of the named register pair; DCX decrements the pair. Again, the Z flag is affected but the C flag isn't. We saw an example of these instructions in use in our first subtraction program.

The DAD instructions do with ease what we did with great difficulty when we earlier added two 16-bit octal numbers. To do the same addition using DAD we could use Program 6.

```
000    00    MVI,B     006    06    put 25 BCD in B
001    01              045    25    045 (25 hex) is 00100101
                                    or 15 in BCD
002    02    MVI,A     076    3E    put 59 BCD in A
003    03              131    59    131 (59 hex) is 01011001
                                    or 59 BCD
004    04    ADD,B     200    80    add A to B
005    05    DAA       047    27    convert sum to two BCD digits
```

Program 9.

JZ	312	CA	jumps if the Z flag is at 1
JNC	322	D2	jumps if the C (carry) flag is at 0
JC	332	DA	jumps if the C flag is set to 1
JPO	342	E2	jumps if the P (parity) flag is at 0
JPE	352	EA	jumps if the P flag is set to 1
JP	362	F2	jumps if the S (sign) flag is at 0
JM	372	FA	jumps if the S flag is set ti 1

Table 1.

One difference is that our answer is now in HL. We can only put eight bits in A so we can't use that register for a double (16-bit) add. We will see this command is usually used to change the address in HL by adding another address to it, so this works out well. All the DAD instructions add the contents of the named register pair to the HL register pair, and the answer remains in HL. Only the carry flag is affected in a DAD instruction.

One use of the DAD is to move the SP register pair to another register pair. We earlier saw the MOV instructions did not include the SP pair. To move the contents of the SP pair to the BC register pair we could use Program 7.

We put 0 in the HL pair first. Then when we added the SP register pair we just moved it (added it to 0 in HL) to HL. We used the regular move instructions to move H to B and L to C; thus we ended up with the contents of the SP register pair in the BC register pair. Note that they are now still in the SP and HL pairs as well.

The DAA instruction is tricky and should be used with a great deal of care. It changes the 8-bit number in the accumulator to two 4-bit BCD (binary coded decimal) numbers (see Program 8).

Note that we are adding decimal, not octal. The 006 is added to the 007:

```
  00000110
+ 00000111
  00001101
```

The answer is 0000 and 1101. This is not a legal decimal number, as it is 13 (1101), but in BCD we only go from 0 to 9 (1001). So the DAA adds 6 to the 1101:

```
  00001101
+ 00000110
  00010011
```

The answer is 00010011, or 0001/0011, or 13 in BCD. Note that we (the DAA) divide the eight bits into two 4-bit groups in BCD, and 1001 is as high as either group can go (this is 9-decimal). If the right 4-bit group is over 9 in decimal, the DAA adds 6 to it. When adding binary:

0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 0 carry 1
1 + 1 + carry 1 = 1 + carry 1

and

1000 BCD = 8
1001 BCD = 9

It should be mentioned that the DAA is only used for decimal numbers; don't use it for octal or hex numbers. The answer (after DAA) is two BCD digits in each byte.

Let's try another:

```
  00100101   25 BCD
+ 01011001   59 BCD
  01111110   (the last 4 bits are
+ 00000110   over 9 so we add 6)
  10000100   84 BCD
```

Remember that the DAA instruction adds the 6 automatically if needed. Also, this instruction does not convert octal or hex to decimal.

The AC flag is used in the DAA instruction and notes a carry out of bit 3 as in the above addition. Since we count from right to left—0, 1, 2, 3, etc.—when counting bits, so bit 3 is actually the fourth bit from the right! Don't blame me. I just explain the rules, I don't make them. Keep in mind that when working with computers you usually start counting with 0, not 1. For example, in addressing, the first, lowest-memory address is 000000, not 000001.

Perhaps we'd better write a program for our last addition problem. It will help make the DAA instruction usage clear. See Program 9. The sum, 84 BCD, is now in the A register.

Branch Instructions

This is a good time to introduce the branch instruction group. There are two types, jumps and calls. We'll describe the jumps first.

Each jump instruction is followed by two bytes, the address to jump to. So these are 3-byte instructions. As usual, the first byte is the low split octal half of the address; the next is the high split octal half of the address. (Jump instructions

```
000    00    SUB,A    227    97    put 0 in A (subtract A from
                                   itself)
001    01    MVI,B    006    06    put 002 in B
002    02             002    02
003    03    MVI,C    016    0E    put 003 in C
004    04             003    03
005    05    ADD,B    200    80    add B to A
006    06    DCR,C    015    0D    decrement C
007    07    JNZ      302    C2    is C 0?
010    08             005    05    if not go back to adr 005
011    09             000    00    if yes go to adr 12 (0A hex)
012    0A    HLT      166    76    stop
```

Program 10.

can be found in Part 1.)

The conditional jump means that if the conditions are not correct, the jump instruction and the following two address bytes are skipped and the program hurries on. If the conditions are met, then the program jumps to the address following the jump instruction. Just for the record, jumps are sometimes called branches, but I'll use the word jump.

JMP (303) means the program goes to the following address no matter what. That is, it is an unconditional jump.

JNZ, jump no zero, (302) means the program jumps to the following address only if the Z (zero) flag is set to 0 in the PSW register. If it is a 1 we skip the following addresses and go on with the program. The rest of the instructions work in a similar manner. I will only mention the flag condition in the PSW register that affects the instruction. See Table 1.

One example of the use of the JNZ flag follows. Let's say we wanted to do something three times, such as add a number to itself (multiply times 3). We could use Program 10.

We keep adding 2 to the accumulator until the C register reaches 0, then we halt. This means we multiply the contents of the B register by the contents of the C register, with the result in A.

The JNZ refers to the C register, where, you will remember, the DCR,C affects the Z flag. Since it is the last instruction that affects the Z flag, it is the one tested by the JNZ. Note that we used SUB,A to put 0 in the A register (subtracting A from A always leaves 0); MVI,A followed by 000 would take another byte.

This should be kept in mind: Always try to make your programs as short as possible. They generally run faster, take up less memory and load faster.

This is just one way we can multiply. We can use a similar program to get the power of a number. To cube a number see Program 11.

This time we multiplied B times itself as in the preceding program, but did this C times to cube A. E is used to temporarily store the running total after each multiply. This is one way to raise a number to a power. The final answer will be in the A register in octal or hex. Obviously, because of this the answer can be no larger than 377 octal (FF hex).

These were just two examples of using a conditional jump in a program. You will find that you will usually only use the JMP, JZ, JNZ, JC and JNC in your programs until you get into complicated arithmetic.

We also mentioned calls. This is how we use subroutines in machine language.

A subroutine is a part of a program that is used more than once. Rather than write it out each time we use it, we can use the CALL instruction to jump to the routine, perform it, then automatically return to the program address following the CALL. For example, we could load a sequence of memory locations with ascending numbers to 100 octal, as in Program 12.

First we load the starting address for the memory load in HL, then the ending address in DE. We load the starting number in B and the maximum number + 1 we wish to load into any address in C. Then we CALL the load routine.

```
000    00    SUB,A     227    97    put 0 in A
001    01    MOV E,A   137    5F    put 0 in E
002    02    MVI,D     026    16    put 3 in D
003    03              003    03    power you wish
004    04    MVI,B     006    06    put 3 in B
005    05              003    03    base number
006    06    MOV C,B   110    48    put base number in C
007    07    ADD,B     200    80    add B to itself
010    08    DCR,C     015    0D    C times
011    09    JNZ       302    C2    is C 0?
012    0A              007    07    no, jump to 007
013    0B              000    00    if yes, go to 014 (0C hex)
014    0C    DCR,D     025    15    once for each power
015    0D    JZ        312    CA    is D 0?
016    0E              024    14    if yes, finished
017    0F              000    00
020    10    ADD,E     203    83    no, add total so far to A
021    11    JMP       303    C3    then jump to multiply
022    12              004    04    again
023    13              000    00
024    14    HLT       166    76    finished
```

Program 11.

In 015 (0D hex) we subtract the low half of the ending address from the load address in L to see if they match. If not (result not 0), then we jump back to CALL to load the next address. If they match, we compare the high half of the load address with the high half of the end address to see if they match by subtracting one from another. If the result is 0, a match, we are almost finished.

We still have to load the last memory address because the HL address we just checked hasn't been loaded yet. If we get no 0 result, then we aren't finished, so back we go to CALL at address 012 (0A hex). If we get a 0, then we use the CALL at address 027 (17 hex) to load the last memory address, then stop the computer.

The CALL puts the number to load in A, moves it to memory at the address in HL, then increments B for the next number and HL for the next address. Note that we incremented B and HL after we loaded the number, so, if we loaded 100 last time, we increment to 101 (we only wanted to go to 100 octal). When we subtract C (101, 41 hex) we have loaded 100 (40 hex) and move 000 to B to start the series again. If not 101 (41

```
000    00    LXI,SP    061    31    we need this, you'll
001    01              010    08    see why when we discuss
002    02              000    00    the stack
---    --
011    09    LXI,H     041    21    start address, in this
012    0A              060    30    case 000/060 (0030 hex)
013    0B              000    00
014    0C    LXI,D     021    11    finish address, in this
015    0D              100    40    case 002/100 (0240 hex)
016    0E              002    02
017    0F    MVI,B     006    06    start number
020    10              000    00
021    11    MVI,C     016    DE    maximum number plus 1
022    12              101    41
023    13    CALL      315    CD    load next number
024    14              044    24
025    15              000    00
026    16    MOV A,L   175    7D    check for low address half
027    17    SUB,E     223    93
030    18    JNZ       302    C2    if not
031    19              023    13
032    1A              000    00
033    1B    MOV A,H   174    7C    check for high address half
034    1C    SUB,D     222    92
035    1D    JNZ       302    C2    if not
036    1E              023    13
037    1F              000    00
040    20    CALL      315    CD    do it one last time
041    21              044    24    to load the last
042    22              000    00    memory address
043    23    HLT       166    76    finished
044    24    MOV A,B   170    78    put number in A
045    25    MOV M,A   167    77    put number in address in HL
046    26    INR,B     004    04    next number
047    27    INX,H     043    23    next memory address
050    28    MOV A,B   170    78    see if we reached the
051    29    SUB,C     221    91    highest number to store
052    2A    JNZ       302    C2    if not
053    2B              057    2F
054    2C              000    00
055    2D    MVI,B     006    06    reset B to 0
056    2E              000    00
057    2F    RET       311    C9    return to program
```

Program 12.

RET	311	C9	unconditional return
RNZ	300	C0	return if zero flag is 0
RZ	310	C8	return if zero flag is 1
RNC	320	D0	return if carry flag is 0
RC	330	D8	return if carry flag is 1
RPO	340	E0	return if parity flag is 0
RPE	350	E8	return if parity flag is 1
RP	360	F0	return if sign flag is 0
RM	370	F8	return if sign flag is 1

Table 2.

CALL	315	CD	unconditional call
CNZ	304	C4	call if zero flag is set to 0
CZ	314	CC	call if zero flag is set to 1
CNC	324	D4	call if carry flag is set to 0
CC	334	DC	call if carry flag is set to 1
CPO	344	E4	call if parity flag is set to 0
CPE	354	EC	call if parity flag is set to 1
CP	364	F4	call if sign flag is set to 0
CM	374	FC	call if sign flag is set to 1

Table 3.

hex), we jump to 000/046 (0026 hex), the return from the CALL.

Although we used the call twice, we only had to write it out once. This is where CALLs are useful. This rather trivial example of the CALL should give you the idea of where it should be used. Ordinarily a CALL routine is used many times in a program, from many different places in a program.

The CALL requires the RET instruction and the CALL instruction, a total of four bytes. As long as the CALL is used more than one place in a program and the space saved by not writing the routine again is over four bytes, the CALL is worth using.

There are conditional CALLs just as there are conditional jumps. The mnemonics are the same, with the substitution of C for J. See Table 2. The returns from a CALL can also be conditional. The mnemonics are in Table 3.

Next month we'll complete the series with a description of the rest of the 8080 instruction set, including the logic instructions. Then we'll discuss the stack and a useful programming method called hand assembling. More program examples to help you understand the instructions will be included. Don't miss it. ■

Reader Service—see page 179

Parallel Port to RS-232 . . . Inexpensively

I/O ports are always at a premium. This remedy uses readily available kits as a basis for a parallel-to-serial conversion.

Rod Hallen
Road Runner Ranch
PO Box 73
Tombstone AZ 85638

It seems that you never have enough I/O ports when you start interfacing your computer with peripheral devices. I have been driving a Teletype Model 43 KSR with my SOL serial RS-232 port for some time. The 43 is great for program listings and other day-to-day utility printing tasks, but the character set is a little small and the paper is a little thin for letters and manuscripts.

After much procrastination, I decided to get busy and interface the Carterfone Selectric I/O Data Terminal that I have been using as a typewriter to the SOL. This terminal contains an RS-232 interface and is EBCD coded. The ASCII-to-EBCD conversion was easily taken care of in software, but I still needed a serial port.

My first consideration was to switch my existing 232 port between the 43 and the Selectric as needed, but I quickly gave up that idea. The 43 runs at 300 baud and the Selectric at 134.5. It is possible to modify the SOL PC board to produce the 134.5 baud clock, but I would still have to manually switch the baud rate, and the switches are not readily accessible. Besides, I'd rather control all of my switching with software.

I considered building up a parallel-to-serial conversion on an S-100 wire-wrap prototype board, but that would have entailed decoding the addresses for an I/O port and a status port. At about this stage in my thinking, I realized that the SOL parallel port wasn't being used, that it was already decoded and that it included a status port. What I needed was something that would go between the parallel port and the Selectric.

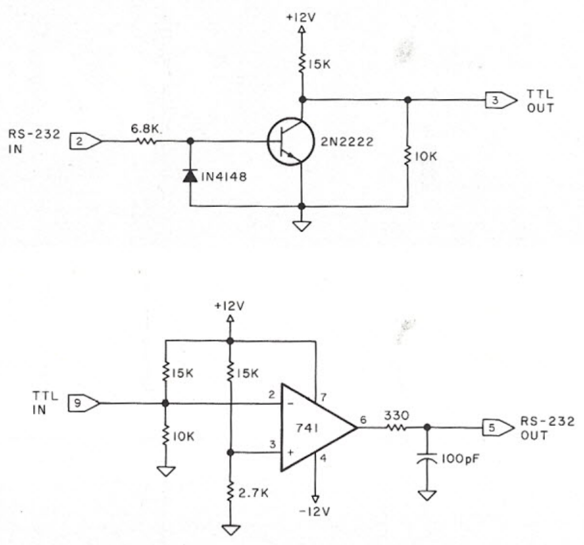


Fig. 1. The Electronic Systems TTL-to-RS-232 interface kit. You can clearly see that the two directions of transmission are completely independent of each other.

Conversion Package

Electronic Systems has been advertising a UART and baud rate generator package and a TTL-to-RS-232 converter for sometime (see Table 1). In fact, I saved over $200 by using their TTL-to-RS-232 board, instead of the Teletype version, in my Model 43. The UART board calls for a 44-contact edge connector, and the TTL-to-RS-232 board has a ten-contact edge that requires some kind of mounting arrangement, but that is a minor problem.

I wrote for both board kits, which arrived promptly. The documentation with the 232 converter is skimpy but adequate since this is a simple circuit (see Fig. 1). Although I have been calling this a TTL-to-RS-232 converter, it actually converts both ways—TTL to RS-232 and RS-232 to TTL—and each section is completely independent of the other for full duplex operation.

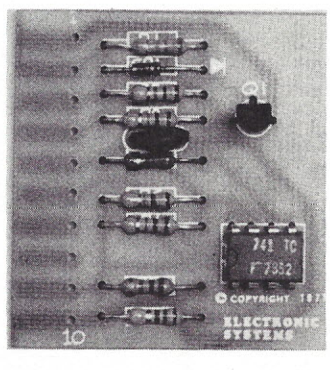
Likewise, the UART board documentation is slender but adequate. This board will also run full duplex (see Fig. 2). If you happen to have a few parts lying around, especially a UART such as the AY-5-1013 or AY-5-1014, you can buy the boards without parts and save even more money. In fact, you can purchase all of the Electronic Systems products as bare boards.

Assembly and Installation

While neither board is solder-masked, the layout is not tight and construction is fast and easy. All component locations are screen-printed to help in the assembly process; parts layout diagrams and schematics are also included with the documentation. All ICs are socketed. My total construction time for both boards was less than half an hour.

The next step was to decide how to mount the boards. 44-contact edge connectors with either solder tabs or wire-wrap posts are easy enough to come by, but the ten-contact edge on the 232 converter is a little strange. Solder points are provided for each of the ten contacts, and when I used the converter in my 43, I ran wires directly to each contact instead of using a socket.

My SOL PC is mounted in a six-foot rack with plenty of space available inside. Cannibalizing an old core memory system provided me with a dozen 44-contact wire-wrap edge connectors and some metal bars with holes drilled every half inch along their length. I mounted two of these bars four inches apart just to the rear of the SOL and installed six connectors on one-



TTL-to-RS-232 converter. Actual size is about 1 3/4 inches square.

inch centers. Wire-wrapping power and ground to all of the connector positions finished the basic setup. This gave me a pseudo-motherboard arrangement without the motherboard.

Everything was interconnected as shown in Fig. 3a. A female DB-25 connector plugs into the SOL parallel port, a ribbon cable runs from the DB-25 to the UART edge connector and a three conductor cable runs from the UART to a male DB-25 that plugs into the Selectric. Fig. 3b shows how the 44-contact edge connector counts when looking at it from the solder or wire-wrap side. The UART board is marked A and Z on the front of the board to cut down on the chances of inserting it backwards.

Pins 4 and 5 on the back of the DB-25 that plugs into the Selectric should be shorted together. This ties the RTS (request to send) lead to the CTS (clear to send) lead. Otherwise, the Selectric won't respond to incoming data.

It's almost time to plug in the UART board, but first a few modifications are in order. Rather than just let the 232 board hang loose, I decided to attach it to the UART board. I did this by drilling a small hole in the upper left-hand corner of the 232 board (looking at it with the edge contacts pointing down) and a similar hole in the UART board about 3/8 of an inch to the left of pin 23 of the UART (with the board similarly oriented). Both of these holes can be drilled without touching any circuit board traces. There is also an existing hole in the upper left-hand corner of the UART board that can be used.

A one inch bolt and a half inch standoff complete assembly. Both the UART and 232 boards have plated-through holes in each of the traces that run to the connector contacts. It is easy to wire the two boards together with short wires. Again, see Fig. 3a. The serial out data from pin 25 of the UART normally goes to edge connector contact 20.

In my version, a thin Teflon-insulated wire is soldered to UART pin 25 (serial data out) on the bottom of the board, run through one of the PC board holes and soldered to 232 board contact 9 (TTL IN). Another wire goes from 232 board contact 5 (RS-232 OUT) to UART board contact M (a vacant contact).

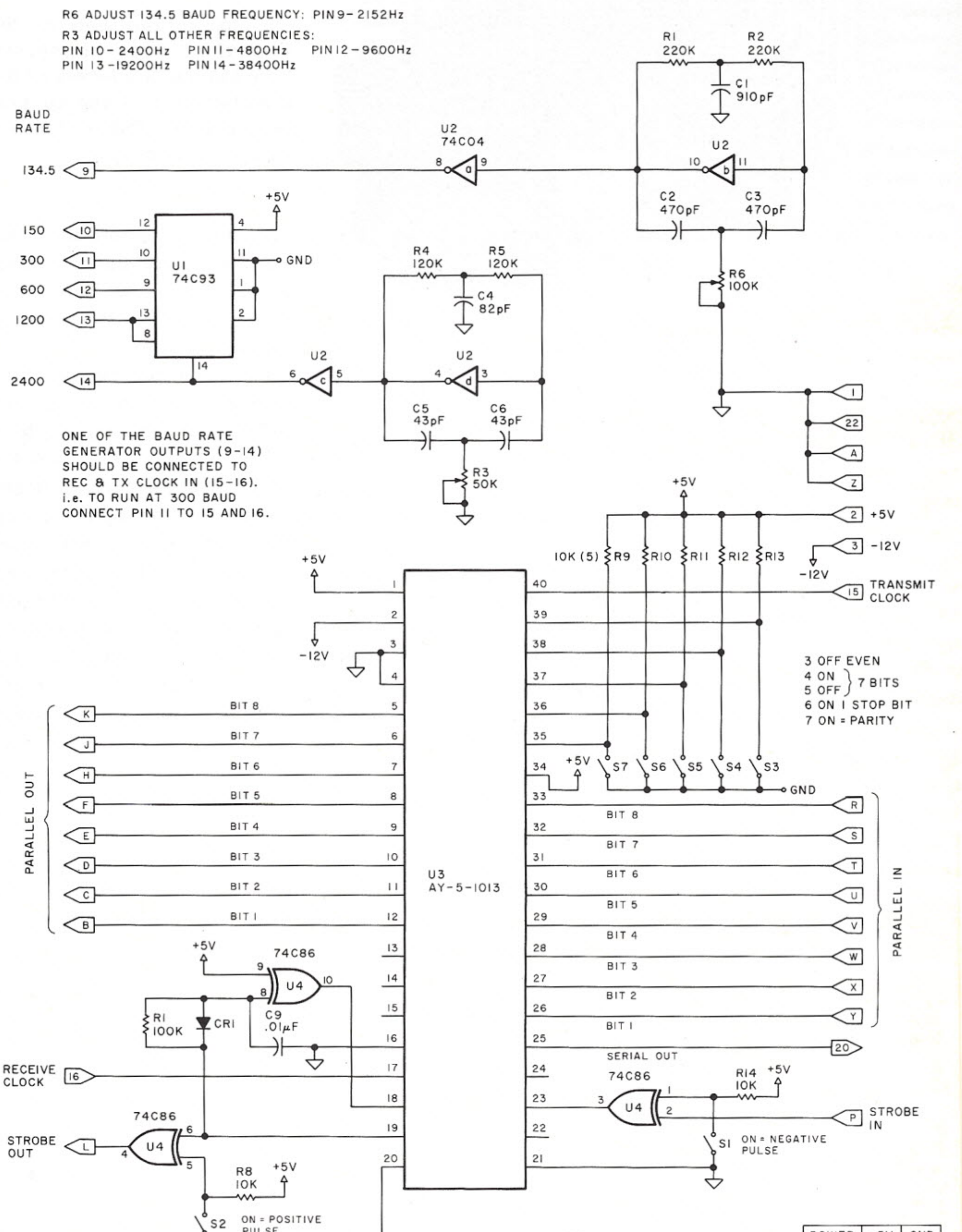
Minus 12 V dc and ground can be strapped from the UART board (contacts 3 and 12) to the 232 board (contacts 6 and 1), but since +12 is not normally provided to the UART board, I ran a wire from Contact N(vacant) to 232 board contact 4 (+12 V dc). Plus 12 is then connected to contact N.

One other modification to

TTL-to-RS-232 Interface	Complete kit	$ 7.00
	Bare board	4.50
UART & Baud Rate Generator	Complete kit	35.00
	Bare board	12.00

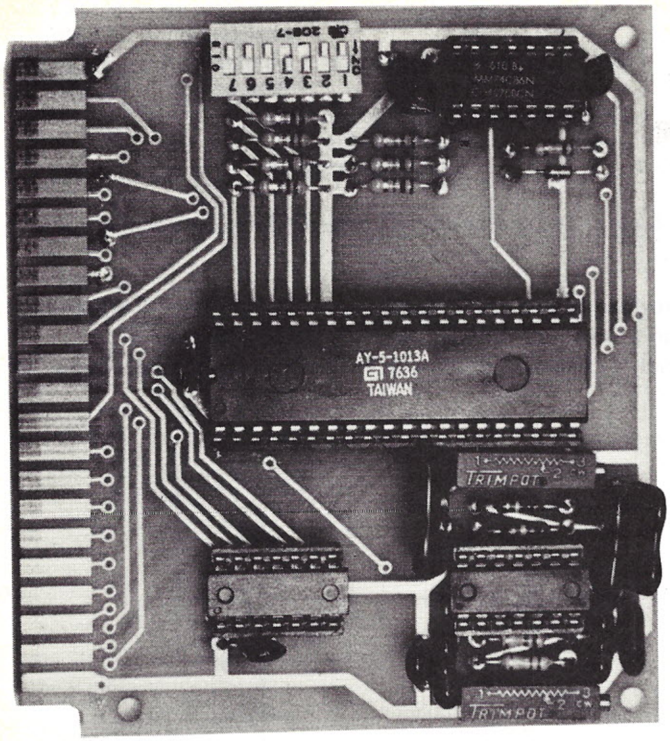
Available from: Electronic Systems
PO Box 21638
San Jose CA 95151

Table 1. The source and prices for the items used in this article.



POWER	+5V	GND
U2	14	7
U4	14	7

Fig. 2. The UART and baud rate generator kit. While not quite so obvious, the transmit and receive functions are separate to allow full duplex operation. One of the baud rate clocks (contacts 9 to 14) is connected to the transmit clock input (contact 15) and the receive clock input (contact 16) to set the baud rate. If an AY-5-1014 is used instead of an AY-5-1013, the −12 V dc supply is not needed. It will still be required for the RS-232 board, however.



UART and baud rate generator. This board measures 3 1/2 inches high by 4 inches wide. My combined board can be visualized by picturing the RS-232 board mounted directly on top of the the UART.

the UART board is required. The SOL parallel port (and, I suspect, most other parallel ports are the same) needs something to tell it on its PXDR lead when one character has been transmitted and it is OK to send the next one to the UART. The UART has a THRE (transmitter holding register empty) lead that goes high when it is ready to accept the next transmit character. THRE is not implemented on the Electronic Systems UART board, but it is easy to do so.

While THRE is active high and the SOL is looking for an active low on its PXDR (parallel external device ready) lead, this is no problem. There is a spare inverter section in U2 that can be used. Fig. 3a shows this mod. Wires are run from UART pin 22 (THRE) to U2 pin 1 and from U2 pin 2 to edge connector pin 17 (vacant).

The only other lead, other than the parallel data leads and ground, that is used between the SOL and the UART is the POL (parallel output load). This

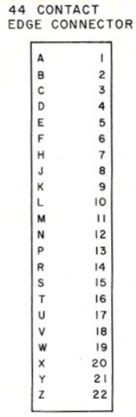


Fig. 3b. Bottom view of the 44-contact edge connector. Note that certain letters of the alphabet (G, I, O and Q) have been skipped. This is standard for this connector.

active low signal tells the UART that the data on the data leads is stable and can be strobed into the transmitter holding register.

All of the information that I have covered so far is concerned with transmitting (outputting) data to the Selectric print mechanism. I have chosen not to use the Selectric keyboard as an input device since I already have two other keyboards serving this purpose. However, input from the Selectric is possible and easy to implement. Modifications in the other direction would probably follow Fig. 4. I have not tried these but see no reason why they would not work.

Baud Rate

As soon as we set the data rate clocks on the UART board, we'll be ready to go. There are two onboard clock oscillators. One provides the 110 baud data rate (Model 33 Teletype and similar) and the other outputs 150, 300, 600, 1200 and 2400 baud. Each of these is brought out to the edge connector (contacts 9 to 14), and the desired one is cross-connected to the transmit and receive clock inputs (contacts 15 and 16).

As I mentioned earlier, the Selectric requires a 134.5 baud clock. Both clock oscillators incorporate trimpots for setting the oscillators right on frequency. There is enough adjusting range in the 110 baud clock trimpot (R6) to reach 134.5. The UART calls for a clock input that is 16 times the desired baud rate, which means that R6 is adjusted for a frequency of 2152 Hz at edge contact 9. The board must, of course, be plugged in or otherwise powered up to make this adjustment.

When I first set up the UART board, I didn't have access to a frequency counter so I had the SOL dump a steady stream of characters to the Selectric while I slowly turned R6. After I was getting good copy, I found both the minimum and maximum setting of R6 that still allowed error-free printing and then set the pot midway between these two points. A later frequency counter check showed that I was within 20 Hz.

In addition to the choice of baud rates, the UART board

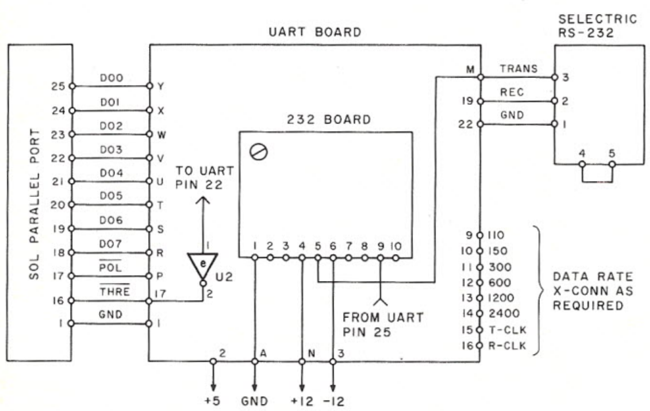


Fig. 3a. Interconnect and modification drawing showing the electrical mating of the two boards. All wiring shown within the outline of the UART board was added by the author. This accomplishes transmit (output) only.

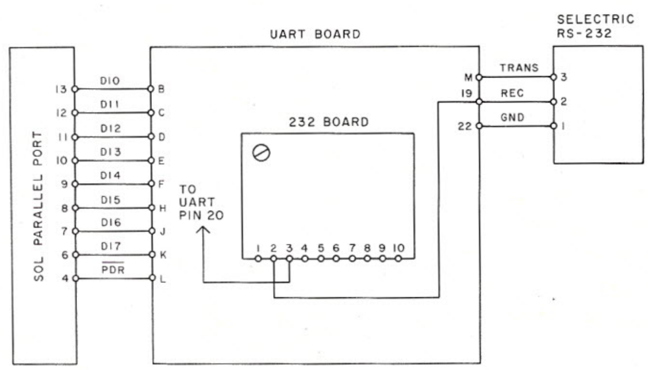


Fig. 4. Receive (input) connections for the Selectric keyboard. This is untried and is presented as a possible starting point. Connections shown in Fig. 3 have been omitted, but ground and power will be required. Later revisions of the SOL PC reverse the order in which the data in pins (DI0 to DI7) are numbered. My SOL is revision D.

provides other options as well. An on-board multiple DIP (double in-line package) switch controls the features listed in Table 2. In the Selectric implementation that we have been discussing, the following switch settings were used: S1—ON, S2—OFF, S3—ON, S4—OFF, S5—ON, S6—ON and S7—ON.

Conclusion

The SOL SOLOS monitor makes provision for four command-accessible output ports. Port 0 is the video screen, 1 is the serial 232 port, 2 is the parallel port and 3 is a custom port. When I want the Model 43 to print, I type SET O = 1, and all output goes to the 43 until I change it. SET O = 2 sends all output to the parallel port (and the Selectric), but I can't do it that way because the output data would be ASCII, which the Selectric doesn't understand.

By using the custom port command, I can route the ASCII data to an ASCII-to-EBCD conversion routine and then to the parallel port. This routine also keeps track of whether the Selectric is in upper or lowercase, and it transmits a shift code when necessary. Even if my Selectric was ASCII-coded, I would still have to keep track of the current shift condition. That is why I gave up on my hardware ASCII-to-EBCD project. It is not possible just to dump ASCII data on an ASCII-coded Selectric and expect to get correct copy.

The SOLOS monitor will also insert any number of required nulls after a carriage return to allow the Selectric enough time to complete the return before the next character is sent out.

While this article relates my experiences interfacing an RS-232 Selectric to a SOL parallel port, the same basic procedure should work with any parallel port. SOL's POL, PXDR and PDR will most likely be called something else, but the equivalent function should exist. A little reading of your manual should clear this up nicely.

Switch	Function	Coding
S1	Input strobe polarity	ON = NEG, OFF = POS
S2	Output strobe polarity	ON = POS, OFF = NEG
S3	Parity	ON = ODD, OFF = EVEN
S4 & S5	Bits per character	S4 S5 Bits
		ON ON 5
		OFF ON 6
		ON OFF 7
		OFF ON 8
S6	Stop bits	ON = 1, OFF = 2
S7	Parity	ON = PARITY, OFF = NO PARITY

Table 2. Definitions for the seven-position on-board DIP option switch. The transmit and receive clock inputs can each be strapped to a different baud rate, but the option switches pertain to both directions of transmission.

All in all, this has been a worthwhile project. Other than the modifications that I have described, my only other suggestion to Electronic Systems is that they combine both the TTL-to-RS-232 conversion and the UART and baud rate generator functions on one board. It appears that this could be done without too much trouble.

There are many RS-232 Selectrics on the market, and the prices are dropping fast as more and more buinesses upgrade to faster printers. I think that this is the best printer buy that there is right now. In this article I've presented to you a problem that I was faced with and I've also shown you how I solved it to my complete satisfaction. It took me longer to write about it than it took me to do it.■

Reader Service—see page 179

Free Speech Lessons for the TRS-80

Lonely? No one to talk to? Not if you have a TRS-80 around the house.

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Radio Shack's TRS-80 has celebrated its first birthday. As a very quick learner, the TRS-80 has acquired quite a bit of knowledge in its first year. But, just like its human counterpart, the infant TRS-80 has remained silent except for a little humming from its power supply or an occasional crackle from the video monitor. Today, however, the baby TRS-80 will startle its parents by uttering its first words.

Teaching the TRS-80 to talk is quite simple. It already has the vocal chords (tape recorder), and it is equipped with a means to exercise them (the PRINT # statement). Note: While this article is based on the software of the Radio Shack TRS-80, the basic concept should be applicable to any computer that can write data to a cassette tape recorder.

The PRINT # statement, described in Appendix B, page 221 of the Level I User's Manual, is used to write data to a cassette recorder. While this is its normal function, disconnecting the AUX and EAR plugs on the recorder allows the PRINT # statement to be used as a remote control to elicit a verbal response under software control.

The normal execution time of the PRINT # statement is four to five seconds. This includes the recorder turn-on time and the actual data recording. Four seconds is not enough time for many of the responses you might like your computer to say; therefore, it is necessary to find a way to extend the speaking time. This can be accomplished by using a timing loop (FOR-NEXT). By programming the loop, any length speech can be recited by the computer.

The Program

However, before the computer can speak, it must be taught what to say. The program shown in the listing is the computer's tutor. It will allow you to teach the computer what to say and when to say it. This program can be used alone or it can be added to the end of the main program, which will direct the computer to speak.

How the program is used depends on whether you want to add the computer's speech on the same tape following the source program or on a tape separate from the source program. The most convenient method is to record the speech on the same tape as the source program. This will eliminate the need to load a second tape after the source program has been loaded. It also eliminates having to cue the tape to "synchronize" the speech.

The cost of these benefits is that the tutorial program steps have to be included at the end of each program that will utilize computer speech. Although the program appears lengthy, it can be shortened if you don't want all the instructions and options.

The program operates as follows. Statement 29999 END prevents the user's main program from "bleeding" into the tutorial subprogram. Statements 30000 through 30130 are self-explanatory. (For non-TRS-80 users: CLS will clear the screen, and P. is short for PRINT.)

Statement 30140 calculates how many time periods of 4.2 seconds it will take to satisfy the time requested in statement 30130. 30150 and 30160 are used to print a bar "clock" on the monitor. This bar across the screen will be shortened in 4.2-second chunks during the recording time. This will give a quick visual indication of how much time is left in making a recording.

Statement 30300 turns on the recorder. The FOR (F.) NEXT (N.) loop determines how many 4.2-second periods the recorder will be on for. 30305 is used to decrement the time bar by one 4.2-second period. The remaining steps in the program allow the user to edit the recording, change the recording, make another recording in sequence or to complete the recording session.

Adding Speech

Inserting speech into a program is now very simple. At the point in a program where you want to have the computer talk (e.g., giving instructions, praise, etc.), insert the statement T=s:GOSUB 29990; where "s" is the length of time in seconds it will take to record the speech. Subroutine 29990 consists of three lines, which will match the timing sequence in the tutorial program (see Example 1).

Note: It is a good idea to keep a list of each usage of subroutine 29990 and the value of T used. This will be helpful in making the series of recordings to be used in the program.

Restrictions

Unfortunately, since this is the first speech lesson for the TRS-80, there are some limitations to keep in mind. The 29990 subroutine simply turns on the recorder and will play what is

```
29990  T=INT((T+2.7)/4.2)
29994  F.I=1 TO T: P.#
29996  F.J=1 TO 5: RESET(127,47):N.J:N.I
```

Example 1.

P. = PRINT
F. = FOR
N. = NEXT
S. = STEP
G. = GOTO
IN. = INPUT
PRINT AT (loc) Prints starting at the designated position (loc) on the monitor.
SET(x,y) RESET(x,y) Turns on or off one of the 6144 2×8 dot matrices used for graphics. The location is designated by x and y. Abbreviations are S. and R.
CLS Clears the screen.

Table 1. Radio Shack abbreviations and commands used.

on the tape at that position. Using the tutorial program with the subroutine 29990 lets the recording and playback be "synchronized" under software control. This will allow you to add speech in the programs you write; but you must record each occurrence of speech separately. This program can not refer to the same sentence several times.

Also, as all speech is recorded and played back sequentially, you must be careful not to put a call to 29990 in a branch that may not be taken unless it is the last speech on the tape.

Even though this program will probably replace a PRINT statement in a program, it is a good idea to write out the speech you plan to insert. After writing it out, time yourself while reading it out loud. This will allow you to insert the correct number of seconds for T.

```
29999  END
30000  CLS:P."UNPLUG THE 'EAR' & 'AUX' PLUGS: N=0
30002  P."REMOVE THE PLASTIC MIKE PLUG"
30100  N=N+1
30110  P."THIS IS YOUR RECORDING NUMBER";N
30115  P."PRESS THE PLAY/RECORD KEYS"
30120  IN."TYPE IN THE EXACT TAPE COUNTER POSITION ";A(N)
30130  IN."ENTER RECORDING TIME IN SECONDS ";T
30140  T=INT((T+2.7)/4.2)
30150  CLS:F.X=T*5+5 TO 6 S.-1:SET(X,5):N.X
30155  P.AT 0;"GET READY";:F.I=1 TO 2000=N.I
30160  P.AT131;"START": P.AT192;"RECORDING";
30170  X=X+1
30300  F.I=1TO T:P.#
30305  F.J=X TO X+4:RESET(J,5):N.J
30310  X=J:N.I:P.:P.:P.:P.
30400  P."DO YOU WANT TO 1)EDIT RECORDING";N;" 2)RERECORD RECORDING";N
30405  P."3)MAKE RECORDING";N+1;" 4)STOP";
30410  IN.A:ONAG.30495,30450,30100,30900
30450  CLS:P."TO RERECORD RECORDING";N;"REWIND TAPE TO EXACT POSITION"
30445  P.A(N);"PRESS PLAY/RECORD KEYS, AND HIT ENTER KEY";
30460  IN.A$:N=N-1:G.30100
30495  CLS:P.:P.:P.:P.
30500  P."TO EDIT RECORDING";N;"REWIND TAPE TO EXACT POSITION";A(N)
30510  P."PRESS THE PLAY KEY, AND HIT THE ENTER KEY";
30520  IN.A$:G.30300
30900  CLS:P."REPLACE PLUGS AS DESIRED":G.29999
```

Program listing.

Conversable Computer

After you have written your program, you can test it by placing an old cassette in the recorder. Type RUN 30000, and the tutorial program will instruct you how to proceed. After you have completed all of the recordings, rewind the tape to the starting position (if you forgot to write it down, type in P. A(1) to the BASIC prompt >, and the computer will tell you the beginning position). Make sure the PLAY key is depressed on the recorder and the EAR plug is removed. You are now ready to run your program and listen to it speak to you.

Once you have your program and all speeches debugged to your satisfaction, place a new tape in the recorder. Making sure you have replaced the EAR and AUX plugs, save the program on tape using the CSAVE command. As soon as the >READY appears on the screen, type in RUN 30000.

You are now ready to make the final speech recordings for use in subsequent runnings of your program. With the speech patterns recorded after your main program, it will not be necessary to "synchronize" your tape. This is automatically done after you load the tape via the CLOAD command.

When running the program, remember to remove the EAR plug after it has been loaded from tape. For those who do not want to be bothered by having to remember to unplug the EAR plug each time, it may be possible to jumper the earpiece jack such that the speaker is connected at all times while the computer's earplug is bridging the speaker. (This will also allow you to hear the data being read into the computer.)

No longer is it necessary for your computer to communicate by writing its messages on a video monitor, now it can talk when it wants. Just watch the expressions on the faces of your family and friends the next time you demonstrate your computer and it responds by speaking, "Hello, I'm a friendly computer. How are you today . . . ?" ■

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Let's Go Flying

Whether you're a microcomputerist who enjoys flying or an aviator who owns a micro—dive into this program.

```
Enter date [MM/DD/YY]: 04/15/78
What is your STARTING POINT ?JEROME
What is the ELEVATION at the JEROME airport ?4038
What is your CLIMBING AIR SPEED and RATE OF CLIMB ?80,300
What is your starting USABLE FUEL and FUEL CONSUMPTION
(use gallons or pounds) ?58,12.7
What is your TRUE AIR SPEED ?125
What is the ALTITUDE of your flight ?5500
What is the DESTINATION of your flight ?BOISE
What is the ELEVATION at the BOISE airport ?2858
How many LEGS on the flight from JEROME to BOISE
?2
Do you want a return Flight Plan (1=yes) ?1
LEG # 1    * * * * * * * * * * * * * * * * *
END POINT of leg (3 LETTERS) ?ALK
LENGTH of leg ?43
TRUE COURSE ?274
What is the WIND DIRECTION ?270
What is the VARIATION (enter EAST as -) ?-16.5
What is the WIND SPEED ?15
LEG # 2    * * * * * * * * * * * * * * * * *
END POINT of leg (3 LETTERS) ?BOI
LENGTH of leg ?51
TRUE COURSE ?291
WIND DIRECTION (same as previous leg?)(1=yes) ?1
VARIATION (is it the same as previous leg?)(1=yes) ?1
WIND SPEED (is it the same as previous leg?)(1=yes) ?1

          Flight Plan from JEROME to BOISE

          04/15/78
          Starting Altitude  4038  Ending Altitude  2858
          Time to climb to  5500    4.87 min.  Travelling   6.50 miles
```

LEG	STR-END	COURSE	MAGNETIC COURSE	LEG LEN	USABLE FUEL	TIME	GROUND SPEED
1	JER-ALK	274.	272.	43.	52.7	0 24 51	111.
2	ALK-BOI	291.	287.	51.	47.0	0 27 8	113.

```
Total Time =  0: 51' 59    Fuel Used =  11.01    Distance =  94.00
Average Ground Speed = 108.47

Flight Plan from BOISE to JEROME

04/15/78
Starting Altitude  2858  Ending Altitude  4038
Time to climb to  6500   12.14 min.  Travelling  16.19 miles
```

LEG	STR-END	COURSE	MAGNETIC COURSE	LEG LEN	USABLE FUEL	TIME	GROUND SPEED
1	BOI-ALK	111.	115.	51.	52.6	0 25 36	137.
2	ALK-JER	94.	96.	43.	48.6	0 18 34	139.

```
Total Time =  0: 44' 10    Fuel Used =   9.35    Distance =  94.00
Average Ground Speed = 127.67
```

Sample run.

If you live in a remote location as I do, you may be finding it difficult to learn to program in BASIC or any other language. This is probably true even for those in large cities. Books on BASIC are fine up to a point, but they only include the most basic fundamentals (pun intended).

I find that studying programs published in magazines such as *Kilobaud* is very helpful. You can study the cute tricks used by those more learned than yourself. While many of these programs need to be modified to run in the Maxi-BASIC that I usually use, I find these tutorial practices fun and edifying. The included program uses many of these lessons I have learned.

The Program

The primary task necessary to all flights is the flight plan. Every flight should have one, but they take time and are difficult. The Flight Plan program solves this problem. Enter the data and let your computer do the work.

Several features should be explained. The data for the origin, destination, airplane performance, etc., are requested in the first portion (lines 70 to 340) of the listing. Line 350 requests the number of legs for the flight. This starts a loop for data on each leg. As you can see, it gives you the option to use the same wind direction, variation and wind velocity as the previous leg.

You should remember that all winds above ground level are given in knots. If you wish to use miles per hour in all calculations, you should add the following line to convert the winds:

```
765 U(N)=U(N)*1.15162642
```

Other custom conversion useful to you can be included to fit your airplane, etc.

When the printout of the Flight Plan begins, a heading is printed. This includes climb-out time and distance while climbing. By following the program, you will note that this calculation is not included as part of the time or distance in the body. In its place I have used the rule-of-thumb method of adding two nautical miles per thousand feet (lines 2030,

Program listing.

```
10  REM - FLIGHT PLAN WRITTEN BY DR. JACK N. ADAMS, JEROME, ID.
20  REM - MAR. 1978 - VER 2.0
30  #TAB(26);"Flight Plan"
40  #"" : #""
50  DIM A$(20) : DIM B$(20) : H=0 : X=1 : B=0 : R=0 : K=0
```

2040). You may need to change this for your airplane.

Another feature is found in the fuel calculations. Here I have used a check for low fuel. If you are using this program for instrument flying, you should start with one hour more fuel on board than you have shown as usable. Usable fuel printed in the table is for the fuel remaining at the end of the leg.

I have also included a return flight plan option. A 1 entered in response to line 440 sets a flag. (Do not enter a 9; that's another flag!) The computer will reverse all the true course headings by 180 degrees. Then it calculates a return flight plan at an elevation 1000 feet above the previous flight.

Because the program is written in Business BASIC from Digital Group, I must explain several lines that have statements not known in polite circles. In line 70 the DATE is a special dedicated variable name. It also shows up in lines 830 and 1030. Lines 380 to 420 relate DIMs. I think this may be unusual. What I'm doing here is (1) setting the dimensions for the Leg Loop and (2) building a string for the starting and ending identifiers. I hope your version of BASIC is less busy than this in its string handling.

Line 430 sets the first three letters used in the starting point as the first identifier. The rest of the string is composed of the three letters used as end points. Line 790 is a command to start the printer. The close is found in line 2060. I used a "w" in line 2070 because my printer cannot print a control character (CTRL-L).

At the end of the program I included the full function library. The program only uses the function for arc-sine. The others are here because some people may not have found such a library for these functions.

The entire program takes about 5.5K of memory. If you drop all the remark statements and the functions not used, it will fit in just over 4.2K bytes. Good luck and happy flying. ■

```
60  M=1
70  INPUT DATE
80  #"What is your STARTING POINT ";
90  INPUT A$
100  #"What is the ELEVATION at the ";A$;" airport ";
110  INPUT E1
120  #"What is your CLIMBING AIR SPEED and RATE OF CLIMB ";
130  INPUT O,D
140  REM - CHECK ENTRY FOR ERROR
150  IF (D-O)<0 THEN PRINT "Entry error, C A Speed & R of C reversed"
160  IF (D-O)<0 THEN 120
170  #"What is your starting USABLE FUEL and FUEL CONSUMPTION "
180  #"{use gallons or pounds} ";
190  INPUT G4,G
200  REM - CHECK FUEL ENTRY FOR ERROR
210  IF (G4-G)<0 THEN PRINT "Entry error, Usable Fuel less than GPH"
220  IF (G4-G)<0 THEN 170
230  #"What is your TRUE AIR SPEED ";
240  INPUT P
250  #"What is the ALTITUDE of your flight ";
260  INPUT A
270  IF (A-E1)<0 THEN PRINT "NOTE - ALTITUDE MUST BE HIGHER THAN ";A$;" AIRPORT!"
280  IF (A-E1)<0 THEN 250
290  #"What is the DESTINATION of your flight ";
300  INPUT B$
310  #"What is the ELEVATION at the ";B$;" airport ";
320  INPUT E2
330  IF (A-E2)<0 THEN PRINT "NOTE - ALTITUDE MUST BE HIGHER THAN ";B$;" AIRPORT!"
340  IF (A-E2)<0 THEN 250
350  #"How many LEGS on the flight from ";A$;" to ";B$
360  INPUT Q
370  DIM L(Q),C(Q),W(Q),V(Q),U(Q),A(Q),S(Q),F(Q)
380  Q1=(Q+1)*3
390  DIM S$(Q1)
400  FOR I=1 TO Q1
410    S$=S$+" "
420    NEXT I
430  S$=A$(1,3)
440  #"Do you want a return Flight Plan (1=yes) ";
450  INPUT Z
460  REM - LOOP FOR EACH LEG OF FLIGHT
470  FOR N=1 TO Q
480    #"LEG # ";N;"    * * * * * * * * * * * * * * * * * *"
490    #"END POINT of leg (3 LETTERS) ";
500    INPUT R$
510    REM - CHECK INPUT FOR LEG IDENTIFICATION
520    IF LEN(R$)<>3 THEN PRINT "IDENT FOR END POINT MUST HAVE 3 LETTERS"
530    IF LEN(R$)<>3 THEN 490
540    S$=S$+R$
550    #"LENGTH of leg ";
560    INPUT L(N)
570    #"TRUE COURSE ";
580    INPUT C(N)
590    C(N)=C(N)*.01745329
595    IF N=1 THEN 630
600    #"WIND DIRECTION (same as previous leg?)(1=yes) ";
610    INPUT J
620    IF J=1 THEN W(N)=W(N-1) : GOTO 660
630    #"What is the WIND DIRECTION ";
640    INPUT W(N)
650    W(N)=W(N)*.01745329
655    IF N=1 THEN 690
660    #"VARIATION (is it the same as previous leg?)(1=yes) ";
670    INPUT J
680    IF J=1 THEN V(N)=V(N-1) : GOTO 720
690    #"What is the VARIATION (enter EAST as -) ";
700    INPUT V(N)
710    V(N)=V(N)*.01745329
715    IF N=1 THEN 750
720    #"WIND SPEED (is it the same as previous leg?)(1=yes) ";
730    INPUT J
740    IF J=1 THEN U(N)=U(N-1) : GOTO 770
750    #"What is the WIND SPEED ";
760    INPUT U(N)
770    NEXT N
780  REM - START OF PRINT OUT ROUTINE
790  OPEN (PRINTER,L) : CLOSE (CRT,L)
800  FOR J=1 TO 5 : #"" : NEXT J
810  #"Flight Plan from ";A$;" to ";B$
820  #""
830  #DATE
840  #"Starting Altitude ";E1;"  Ending Altitude ";E2
850  #"Time to climb to ";A;"  ";%6F2;(A-E1)/D;" min.  Travelling ";
860  #%6F2;((A-E1)/D)*(O/60);" miles"
870  #"" : #""
880  GOSUB 1270
890  GOSUB 1310
900  GOSUB 1270
910  REM - LOOP TO PRINT EACH LEG
920  FOR N=1 TO Q
930    GOSUB 1640
940    GOSUB 1350
950    GOSUB 1270
960    NEXT N
970  REM - PRINT TOTALS
980  GOSUB 1870
990  IF Z<>1 THEN 2060
1000  #"" : #""
1010  #"Flight Plan from ";B$;" to ";A$
```

```
1020 #""
1030 #DATE
1040 #"Starting Altitude ";E2;"  Ending Altitude ";E1
1050 #"Time to climb to ";A+1000;"  ";%6F2;((A+1000)-E2)/D;
1060 #" min.  Travelling ";%6F2;(((A+1000)-E2)/D)*(O/60);" miles"
1070 #"" : #""
1080 B=1 : H=0 : R=0 : K=0 : X=Q1 : Z=9
1090 M=1
1100 FOR N=1 TO Q
1110   C(N)=C(N)-3.1415927
1120   IF C(N)<0 THEN C(N)=C(N)+6.2831853
1130   NEXT N
1140 GOSUB 1270
1150 GOSUB 1310
1160 GOSUB 1270
1170 REM - LOOP TO PRINT EACH LEG
1180 FOR N=Q TO 1 STEP -1
1190   GOSUB 1640
1200   GOSUB 1350
1210   GOSUB 1270
1220   NEXT N
1230 REM - PRINT TOTALS
1240 GOSUB 1870
1250 GOTO 2060
1260 REM - SUBROUTINE #1 - LINE PRINT
1270 FOR J=1 TO 72 : #"-"; : NEXT J
1280 #""
1290 RETURN
1300 REM - SUBROUTINE #2 - HEADING PRINT
1310 #"LEG | STR-END | COURSE |MAGNETIC| LEG LEN | USABLE |   TIME   | GROUND"
1320 #"    |         |        | COURSE |         |  FUEL  |          | SPEED"
1330 RETURN
1340 REM - SUBROUTINE #3 - SPACE
1350 #"    |         |        |        |         |        |          |"
1360 RETURN
1370 REM - SUBROUTINE #4 - SMALL SPACE
1380 #" | ";
1390 RETURN
1400 REM - SUBROUTINE #5 - MATH CALCULATIONS
1410 W=W(N)+V(N)
1420 REM - CALC. MAGNETIC COURSE
1430 A(N)=C(N)+FNS1((U(N)/P)*SIN(W-C(N)))
1440 REM - CALC. GROUND SPEED
1450 S(N)=ABS(P*COS(A(N)-C(N))-U(N)*COS(W-C(N)))
1451 A(N)=A(N)/.01745329
1452 IF A(N)<=0 THEN A(N)=A(N)+360
1453 IF A(N)>360 THEN A(N)=A(N)-360
1460 REM - TIME CALCULATION
1470 IF M=1 THEN 2030
1480 T=L(N)/S(N)
1490 R=R+T
1500 E7=INT(T)
1510 E8=INT((T-E7)*60)
1520 E9=INT((((T-E7)*60)-E8)*60)
1530 REM - TOTAL DISTANCE (K)
1540 K=K+L(N)
1550 REM - FUEL CALCULATION
1560 F(N)=T*G
1570 H=H+F(N)
1580 IF Z=9 THEN 1970
1590 IF N=1 THEN F(N)=G4-F(N) : GOTO 1620
1600 IF F(N-1)-F(N)=<0 THEN PRINT "CAUTION - - STOP FOR FUEL!"
1610 IF F(N-1)-F(N)=<0 THEN F(N)=G4-F(N) ELSE F(N)=F(N-1)-F(N)
1620 RETURN
1630 REM - SUBROUTINE #6 - PRINT LEG DATA
1640 GOSUB 1410
1650 #%3I;M;
1660 M=M+1
1670 GOSUB 1380
1680 IF B=0 THEN #S$(X,X+2);"-";S$(X+3,X+5); ELSE #S$(X-2,X);"-";S$(X-5,X-3);
1690 IF B=0 THEN X=X+3 ELSE X=X-3
1700 GOSUB 1380
1710 #%6F0;C(N)/.01745329;
1720 GOSUB 1380
1760 #%6F0;A(N);
1770 GOSUB 1380
1780 #%7F0;L(N);
1790 GOSUB 1380
1800 #%6F1;F(N);
1810 GOSUB 1380
1820 #E7;E8;E9;
1830 GOSUB 1380
1840 #%6F0;S(N)
1850 RETURN
1860 REM - SUBROUTINE #7 - TOTAL TIME CONVERSION & PRINT ENDING
1870 B7=INT(R)
1880 B8=INT((R-B7)*60)
1890 B9=INT((((R-B7)*60)-B8)*60)
1900 #""
1910 #"Total Time = ";B7;":";B8;"'";B9;"    Fuel Used = ";%6F2;H;
1920 #"    Distance = ";%6F2;K
1930 #"Average Ground Speed = ";%6F2;K/R
1940 FOR J=1 TO 5 : #"" : NEXT J
1950 RETURN
1960 REM - SET FUEL TO BEGINING VALUE FOR RETURN FLIGHT
1970 IF N=Q THEN F(N)=G4-F(N) : GOTO 1620
1980 IF F(N+1)-F(N)=<0 THEN PRINT "CAUTION - - STOP FOR FUEL!"
1990 IF F(N+1)-F(N)=<0 THEN F(N)=G4-F(N) ELSE F(N)=F(N+1)-F(N)
2000 GOTO 1620
2010 REM - ADJUSTMENT IN FIRST LEG FOR CLIMB OUT ALTITUDE
2020 REM - ADD 2 NM/1000 FEET CLIMB
2030 IF N=1 THEN T=(L(N)+(2*(A-E1)/1000))/S(N) : GOTO 1490
2040 IF N<>1 THEN T=(L(N)+(2*((A+1000)-E2)/1000))/S(N) : GOTO 1490
2050 REM - END OF PRINT OUT
2060 CLOSE (PRINTER,L) : OPEN (CRT,L)
2070 PRINT "w"
2080 END
2090 REM -----FUNCTION LIBRARY-------------------------
2100 REM ---------------------------------------------
2110 REM -----FUNCTION FOR ARC-SINE--------------------
2120 DEF FNS1(Z0)
2130 Z1=0 : Z(0)=1.5707963 : Z(1)=-2.145988E-1 : Z(2)=8.897897E-2
2140 Z(3)=-5.0174305E-2 : Z(4)=3.0891881E-2 : Z(5)=-1.7088126E-2
2150 Z(6)=6.6700901E-3 : Z(7)=-1.2624911E-3
2160 IF Z0>=0 THEN Z2=1 ELSE Z2=0
2170 Z0=ABS(Z0)
2180 IF Z0>1 THEN PRINT "FNASI-Argument Error" : STOP
2190 FOR Z3=0 TO 7 : Z1=Z1+(Z(Z3)*Z0^Z3) : NEXT Z3
2200 Z3=1.5707963-SQRT(1-Z0)*Z1
2210 IF Z2=1 THEN RETURNZ3
2220 Z3=-1*Z3 : RETURNZ3
2230 FNEND
2240 REM ----- FUNCTION FOR ARC-COSINE -----------------
2250 DEF FNC1(Z0)
2260 Z4=1.5707963-FNS1(Z0)
2270 RETURNZ4
2280 FNEND
2290 REM ----- FUNCTION FOR ARC-TANGENT ----------------
2300 DEF FNT1(Z0)
2310 Z4=FNS1(Z0/(SQRT(1+Z0^2)))
2320 RETURNZ4
2330 FNEND
2340 REM ----- FUNCTION FOR TANGENT --------------------
2350 DEF FNT(Z0)
2360 Z4=SIN(Z0)/COS(Z0)
2370 RETURNZ4
2380 FNEND
2390 REM ----- FUNCTION FOR COMMON LOGARITHM -----------
2400 DEF FNL0(Z0)
2410 Z1=.43429448*LOG(Z0)
2420 RETURNZ1
2430 FNEND
```

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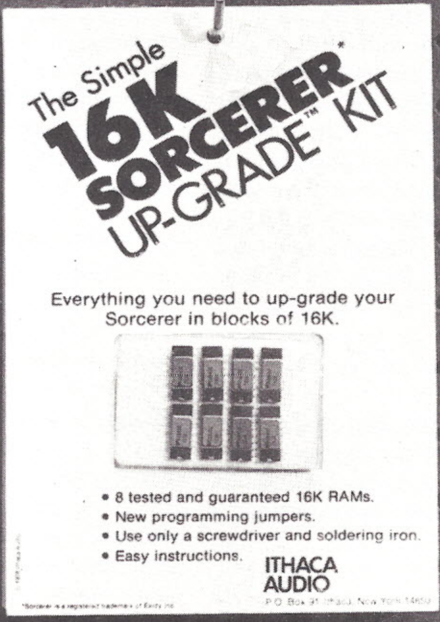

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Floppy Disk System from Tarbell

Is lack of on-line storage slowing you down? Perhaps you need a floppy or two.

Ron Burris
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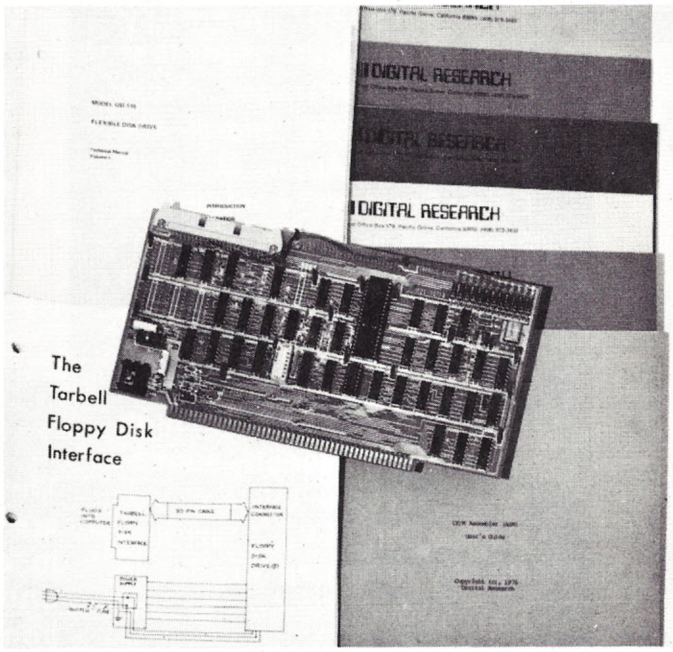
Ewa Beach HI 96706

We recently had the opportunity to test the new Floppy Disk Interface board produced by Tarbell Electronics with two GSI 110 Floppy Disk Drives and Digital Research's CP/M Disk Operating System as modified by Tarbell Electronics. They were tested on a basic Equinox 100 system equipped with 24K RAM.

The Tarbell Floppy Disk Interface is a standard-sized S-100 bus printed circuit board utilizing a Western Digital 1771 Floppy Disk Controller IC to interpret and implement CPU instructions to the disk drive unit(s). It is capable of handling up to four drives. The interface card contains a 32-byte ROM which is enabled during power-up reset to load a sophisticated bootstrap loader from the first two sectors of the first track of the disk into RAM. The ROM is then disabled and control passed to this bootstrap to load the full CP/M and Basic Input/Output System (BIOS) into RAM.

A 50-conductor jack is provided on the interface card for interconnection to the disk drive(s). Versatility of drives used with the interface card is provided by jumpering the various signal and control leads on the card to the appropriate jack pins.



Tarbell Floppy Disk Interface.

This feature allows the Tarbell Floppy Disk Interface to be used with most, if not all, of the currently available floppy disk drives. Every other pin on this jack is grounded to provide increased noise immunity along the connector cable. A 50-pin plug and ribbon cable are provided. Plugs to match various drive units may be provided by the user; they also may be ordered pre-attached.

The documentation for the Tarbell Floppy Disk Interface includes sections on construction, theory of operation, interfacing, testing procedures and programs, schematics and conditions of warranty. The documentation is well written, concise and complete. As new drives are interfaced in the Tarbell lab, documentation for them is added. Sixteen different drive units have been interfaced to date, including all of the most popular units.

GSI 110 Floppy Disk Drive

The GSI 110 Floppy Disk Drive uses standard 8 inch diskettes in a single density mode to provide an IBM-compatible soft-sectored storage capacity of 148K bytes per diskette. Hard-wired options – for using the drive with hard-sectored diskettes in radial, daisy-chain, binary and single drive select modes, for example – are available. Most options are jumper selectable on the electronics board of the drive unit.

The GSI 110 requires 110 V ac, + and - 5 V dc regulated and -12 V dc regulated. Options for on-board regulation of dc voltages are also available.

From unpacking through operation, the GSI 110 exudes quality. It is assembled from premium components and construction is heavy duty for minimum maintenance and long life. Two well-written manuals are provided with each unit sold. They include detail on the operational and maintenance requirements of the drive and its options.

Digital's CP/M Floppy Disk Operating System

The CP/M Disk Operating System has been in existence for over three years in various manufacturers' products and is now available to the hobbyist. It is licensed software, provided by serial number and strictly accounted for. It is perhaps the first complete DOS available to the personal computer user.

The five general commands provided are: DIR (to retrieve the directory or portions of it), TYPE (lists an ASCII file on the console), REN (renames a file), ERA (erases a file or files from the directory) and SAVE (saves memory on the disk for later use).

CP/M is cognizant of the memory size of the system and includes I/O routines for

a number of devices, including keyboard and video display or TTY for a console device, line printer or RO TTY for a listing device, and paper tape reader and punch for reading and punching devices. The I/O devices are addressed through an easily customized package called the BIOS (Basic Input/Output System). A conditional assembly-language listing and instructions for modifying the BIOS for user configurations are provided. At present the BIOS (as provided by Tarbell) will support an Intel, Mits, Imsai, Cromemco or Equinox standard system, as indicated by the user.

In addition to CP/M, software to generate new diskettes with different CP/M capabilities, assemble 8080 assembly-language programs, debug and test 8080 assembly-language programs, load and dump programs in hex, format diskettes, edit new and old files and a BASIC-E compiler and run-time interpreter are provided by Tarbell. All software is completely documented in six booklets combined into one package. Much of the documentation requires help, if you are not experienced in floppy disk systems, but it is all comprehensible. The delivery time for customized BIOS's may run up to 90 days, depending upon previous system requirements and in-stock systems.

Close

Tarbell Electronics does not wish to get into the business of selling complete systems, and encourages the use of local dealers. Local dealers may have hardware readily available and can probably provide any required software modifications much faster than they can be ordered through Tarbell Electronics. The on-board bootstrap may not work with the Morrow (Equinox) Keyed-Up 8080 CPU/Front Panel and some dynamic memories. A "fix" for the Morrow CPU is being prepared and will be available soon. The alternate bootstrap program provided by Tarbell will work with the Morrow CPU in the interim. ■

The Floppy Disk Interface kit is priced at $190; the GSI 110 Floppy Disk Drive is $525; a power supply for one GSI 110 is priced at $75 each. The CP/M operating system and manuals are $95. See your dealer or contact Tarbell Electronics, 950 Dovlen Place, Suite B, Carson CA 90746, (213) 538-4251, for further pricing and operational information.

Reader Service—see page 179

The Wait State Explained

If you've been waiting for an explanation of this phemonenon, the time has come.

Ren Colantoni
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Burbank CA 91503

Newcomers to the personal computer hobby soon hear of an ominous problem called the "wait state." They quickly learn that (1) this has something to do with the transactions between the microprocessor chip or card and the memory of a microcomputer and (2) it is not desirable. Beyond this point, the novice is plunged into a thick fog of misinformation and rumors about the effect of the wait state on machine operation; the speed of memory board x vs that of memory board y; and whether or not the wait state is worth worrying about at all. This article will help clear this fog once and for all.

What Is a Wait State?

The wait state is simply a period of time that the processor chip must wait for the memory to accept output data sent to it or prepare input data and send it to the processor. It is important to note that the processor waits for the memory, not vice-versa. This can be confusing when you read some advertisements for memory products.

When Does a Wait State Occur?

To answer this question, we must first offer some explanations. The word "state" refers to a specific interval of time during which a well-defined function of the processor chip occurs. We will use the Intel 8080A as a typical example.

Refer to Fig. 1, which shows the main logical divisions of time for the execution of a hypothetical 8080A instruction. The entire time required to fetch and execute a complete instruction is called an instruction cycle. This instruction cycle is divided into parts called machine cycles, whose purposes are to accomplish a major logical task of the instruction. These tasks include fetching an instruction byte from the memory, accessing memory to bring a byte of data into the processor or sending a byte of data to an output port from the processor.

The machine cycles are further divided into states. A state is defined as the period of time between rising edges of two consecutive Ø1 clock pulses. During a state, functions are performed by the processor to accomplish the task of the current machine cycle. These functions include placing an address on the address lines, accepting a byte of data from the data input lines or accomplishing an add within the registers and accumulator of the processor itself. There can be as few as three, or as many as five, states required per machine cycle. One to five machine cycles can be required for a complete instruction cycle.

The number of machine cycles and states required depends on the instruction to be performed. Cycles and states increase depending on the number of times the processor must access memory to execute the instruction.

In a simple instruction such as "Move H and L Registers to Stack Pointer Register (SPHL)," the contents of the H and L registers are transferred to the stack pointer register (see Fig. 2). The instruction consists of one machine cycle made up of five states. The first state, t1, places the address of the program counter onto the address lines and requests the byte stored there to be fetched to the processor. This has the effect of bringing the one-byte SPHL instruction into the processor from memory. This t1 state is the same as the first t1 state in any 8080A instruction.

The second state, t2, increments the present address stored in the program counter by one to be ready to access the next byte when needed.

One Instruction Cycle

First Machine Cycle				Second Machine Cycle			Third Machine Cycle	
STATE 1	STATE 2	STATE 3	STATE 4	STATE 1	STATE 2	STATE 3	STATE 1	STATE 2

Fig. 1. A hypothetical instruction cycle showing three machine cycles, each composed of several states.

SPHL Instruction

One Machine Cycle

STATE 1:	STATE 2:	STATE 3:	STATE 4 AND 5:
The contents of the Program Counter are placed on the Address Lines. Proper status lines are raised to cause memory to begin accessing the desired address.	While the memory prepares to transmit data, the MPU increments its Program Counter by 1 to be ready to access the next instruction (SPHL is only one byte long).	The incoming byte is loaded into the Instruction Register. The MPU now knows what to do and prepares for the execution phase of the instruction cycle. In this case, the contents of the H&L registers are to be moved into the Stack Pointer register.	The execution of the instruction proceeds, causing the contents of H and L to be loaded into the Stack Pointer register. Two states are required since two bytes are to be moved. At the end of t5, the MPU will proceed to the first machine cycle of the next instruction.

Fig. 2. The "Move H and L registers to Stack Pointer register" (SPHL) instruction. The first three states of all 8080A instructions, except the RST, are identical as shown above. The functions of the remaining states depend on the nature of the instruction.

(This next byte will be part of another instruction, in our case, since the SPHL instruction is only one byte long.)

The t3 state accepts the data byte presented by the memory and stores it in the instruction register of the processor. It is at this point that the instruction byte can now take control of the computer and cause further processing of a specialized nature to occur.

The last two states, t4 and t5, are then required to perform the instruction and move the contents of the H and L registers to the stack pointer register. Two states are required since there are two bytes to be moved. Note that since only one memory access is needed, only one machine cycle is required. This one access is required to bring the one-byte-long SPHL instruction into the processor. Since all the moving took place within the processor, no further memory accessing was needed.

In this example, we show that the third state of a machine cycle, t3, is the one during which the processor accepts the data from memory. This is typical of any machine cycle in which memory is accessed. This means that the memory must present that data on the data in lines prior to the beginning of t3 (refer to Fig. 3).

After the rise of the Ø2 clock during t1, the address for the desired memory location will be placed on the address lines and the Sync line will be raised. This, along with other status lines, calls the attention of the memory to the address. (The memory circuit has until the fall of the Ø2 clock pulse to recognize its address and prepare to respond.)

At the rise of the Ø1 clock at the t2 state, the selected memory circuit responds by pulling the computer's Ready line low. (This signals to the processor that a memory circuit has responded and is preparing its data for input.) The memory *should* present its data before the beginning of t3 so that the byte can be accepted by the processor during t3. If the Ready line is raised by the memory soon enough, this will occur.

Now suppose, as in Fig. 4, that the memory circuit is not able to respond fast enough to raise the Ready line in the middle of t2. According to Intel specifications, the Ready line must be raised a minimum of 120 nanoseconds prior to the fall of Ø2 during t2 to have data accepted during t3.

If this time frame is not met, a dummy state called a wait state (tw) is inserted by the processor between t2 and t3. This wait state causes the whole system to idle while the memory performs its functions. When the memory does finally raise the Ready line again, the required data will be on the inbound lines and the processor will take it during the following t3 cycle.

If the memory is so slow that the point of 120 ns is reached before the fall of Ø2 of the tw state, a second tw will occur. The t3 state never occurs until the Ready line raises in the early part of the Ø2 clock pulse of a t2 or tw state.

To summarize, then, a wait state is an extra state inserted into a machine cycle in which the memory cannot respond fast enough to raise the Ready line and present or accept data 120 ns before the fall of the Ø2 clock pulse of a t2 state. An extra state, tw, will be inserted between t2 and t3 to permit more response time. If the memory responds fast enough, no extra state is required and t3 immediately follows t2.

How Long Is a Wait State?

This question is easy to answer. The 8080A is nominally rated to operate with a 2 MHz clock. This means that the Ø1 and Ø2 clock pulses are occurring 2 million times a second. Since a state is defined as the time between the rising edges of the Ø1 pulses, the time for each state will be the repetition rate for a frequency of 2 MHz. This amounts to 500 ns per state. Since the wait state, tw, is the same length as any other state, it, too, must be 500 ns long. The instruction execution time, therefore, is increased by 500 ns for each wait state required.

It should be noted that in most 8080A-based systems, the clock frequency is slightly higher than 2 MHz, due to the action of the 8224 clock genera-

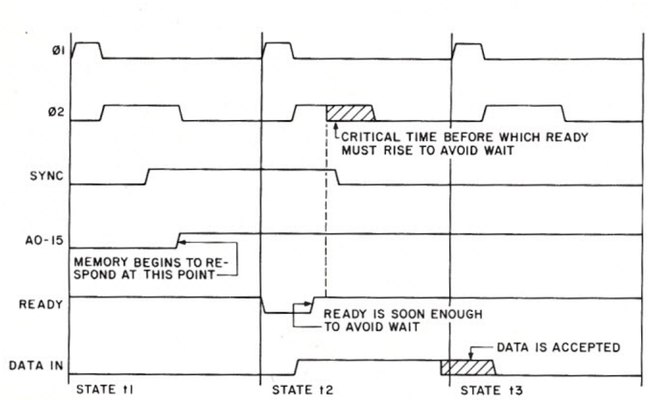

Fig. 3. Synchrogram of memory response with no wait state required. The memory system brought the ready line high in time to avoid the critical time period at the end of Ø2 of t2. The data presented by the memory is accepted by the MPU during t3.

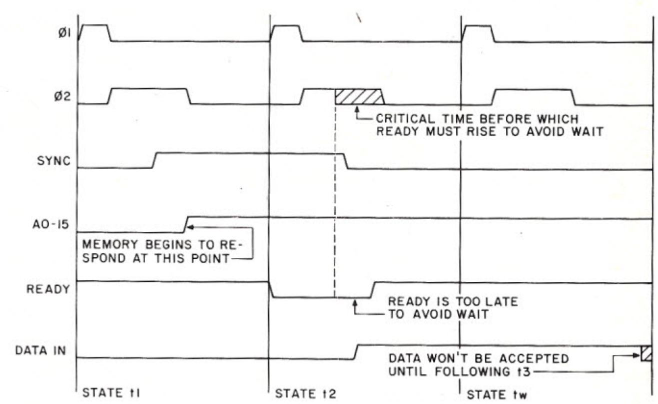

Fig. 4. Synchrogram of memory response with a wait state required. The memory system's response was too late to meet the critical time zone during Ø2 of t2. This forces the MPU into a wait state to give an additional 500 ns for the memory system to prepare to send data.

tor chip and small trimmer capacitors inserted in series with the crystal. Typical state times are 480 to 495 ns.

How Fast Must a Memory Chip Be to Avoid Wait States?

This is the most important question in our discussion since the answer will indicate which chips can and cannot operate without wait states. The memory chips prepare themselves for the acceptance or transmission of data when they find their address presented to them during t1.

At this time, both the proper status information to cause a memory function to occur and the Sync line should be active in the typical S-100 system. These conditions all are present during Ø2 of t1 of a machine cycle. The memory chip must accept data sent to it. At the rising edge of Ø1 of the t2 state, the memory has the option of taking the Ready line low to request a wait.

The critical amount of time, therefore, in which the memory system must respond is that time between the presentation of the address during Ø2 of t1 and 120 ns before the fall of Ø2 during t2. Note that we refer to the "memory system" here, because time is consumed not only by the actual memory chips themselves, but also by the address decoding circuits, buffers and status lines' gating of the board on which the memory chips are installed.

Close inspection of the Intel 8080A specifications reveals the following data. We will assume a state time of 500 ns and the worst-case conditions. The rising edge of Ø2 occurs about 80 ns after the rising edge of Ø1 during t1. The address will be presented and stabilize 200 ns after the rise of Ø2. This means that, at worst, the memory system may begin to analyze the address about 280 ns into the t1 state.

220 ns after the presentation of the address, t1 ends and Ø1 of t2 begins. Again, Ø2 will rise about 80 ns later. The minimum duration of Ø2 is about 220 ns. The Ready line must be high at least 120 ns prior to Ø2's fall. This means that Ready must be high, at worst, 180 ns into t2. By adding this 180 ns to the 220 ns of t1 left after the stabilization of the address, we have a response time, at worst, of 400 ns in which the memory must respond in order to avoid a wait state.

Fig. 5 illustrates these timings. Note that the 400 ns window illustrated is the theoretical minimum, according to Intel specifications, for a properly operating 8080A. The window can be of different lengths, depending on the individual 8080A used and the exact frequency of the system clock. The window can be shortened by slow address and status recognition circuits of the memory system. It can be lengthened by slowing down the system clock.

According to our data, the ideal memory system should respond within 400 ns in order to avoid a wait state. This assumes, once again, the worst possible conditions with which the 8080A could work. In reality, the Ø2 state is longer than 220 ns in most systems. Also, some memory board manufacturers avoid time delays (and cost) by eliminating the buffering of the address lines.

Generally speaking, then, most of the 450 ns boards available will work most of the time without a wait state. Memory boards with cycle times less than 400 ns will certainly work in our example 8080A computer (with a 500 ns state length) if all parts are in good order.

The Overall Effect of the Wait State on Machine Operation.

Obviously, the addition of wait states causes the whole program to take longer to execute. In the case of an instruction that needs only one memory access, such as our SPHL, the time required would increase by 500 ns for each wait state needed during the single memory access.

To illustrate, the SPHL takes five states, or $5 \times 500 = 2500$ ns, or 2.5 us, to execute with no waits. If one wait state is re-

✓ Reader Service—see page 179

quired, 6 × 500 ns, or 3.0 us, are needed.

In complex instructions, the problem becomes more pronounced. The Store H and L Direct (SHLD) instruction, for example, requires five machine cycles and a total of 16 states. With no wait states, this amounts to an execution time of 8 us. If one wait state is needed for each of the five machine cycles, the instruction execution time becomes 10.5 us, which is an increase of over 30 percent.

Naturally, we would all like our computers to operate without wait states—just to say they do, if for no other reason. For the average computer hobbyist, the amount of time lost to wait states is reasonably small and the difference would barely be noticeable. However, there are two cases where extra wait states can be a problem.

The first is in a long program written in BASIC. BASIC is an inherently slow language. Many memory accesses are required just to interpret a single line. In this case, so many wait states may be encountered that the execution time will be minutes longer for a given program than on a system with a faster memory and no waits.

The other situation where wait states become a problem is in a DMA environment such as with floppy disk. In this application, the MPU chip is held inactive by the disk controller via the hold line, and the data and address lines are now under control of the disk control card. The disk controller then provides addresses and data to the memory directly, without MPU intervention.

The speed of the data transfer from disk to memory (or vice versa) is determined by the speed at which the disk turns and the density of the data bits on the disk. Since the data transfer is unstoppable because the disk must be kept moving, any data not delivered or recieved by the memory within the time frame allotted to the transfer will be lost or garbled.

Floppy-disk systems built by the personal-computer manufacturers have a variety of densities and speeds; they are not universally standardized. Therefore, memory speed is important if the disk system you select is not compatible with it. If you buy memory now with a plan for having disk later, consider memory speed so that the future disk will operate properly when it is installed.

Memory Speed Conclusions

1. Most 450 ns memory systems work fine with the average home-computer setup. Except in long programs in BASIC, the time required for wait states is minimal and tolerable.

2. Some memory-board manufacturers assume that their board is always going to be fast enough to keep up with the MPU. Therefore, they do not include any circuit to pull the Ready line low to request a wait. If the memory system's response isn't, in fact, fast enough, data can be dropped or

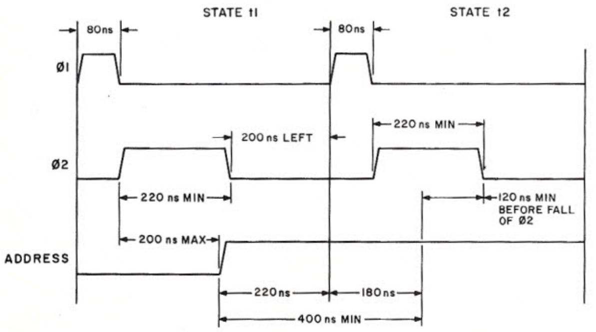

Fig. 5. Under worst-case conditions, the window in which the memory system must respond to the 8080A is 400 ns wide. This is the time between the rise of the address A0-A15 and the point after which the Ready line is ignored, 120 ns before the fall of Ø2 during t2.

garbled with resulting highly intermittent and hard-to-trace program failures.

3. Some 450 ns boards work well with cassette or PROM systems but cannot keep up with a floppy disk. This results in highly intermittent program failures due to data dropped or mixed in the DMA process. This phenomenon seems to run to certain manufacturers rather than the memory chip they use. If there is a disk in your future, stick to known reliable, or faster, boards.

4. The speed of a chip used on a given board is only part of the memory speed story. The board as a whole can be slow as a result of address buffers, status line decoding and output data line buffering. It is wiser overall, from the entire system's viewpoint, to use faster memory chips on a fully buffered board than to play a pulse race game for speed with no buffering.

5. Be aware that a chip doesn't have to be "blown" to be faulty. Most simple memory tests will indicate that certain bits in certain memory locations are either always high or always low. However, a chip that works correctly, but slowly, will fail in a DMA environment and work correctly otherwise. A slow 250 ns chip will still probably be fast enough to cause no errors; a slow 450 ns chip may not.

6. Watch out for boards with no provision to pull the Ready line low if the board is potentially slow enough to require it. If no ready circuit is available and the board has a slow chip or the computer has a fast MPU, data may be available too late and be dropped. A wait state could be added and would solve the problem, but no way to request a wait is included.

A final suggestion is to thoroughly examine the details of any memory board you consider buying before making the purchase. If you don't fully understand the technical details of the board's operation, ask an experienced and/or technically trained person to assist you in learning the details.

However, make your own decisions that best fit your own personal needs, future plans and pocketbook. Too many charlatans and know-it-alls are behind computer-store counters and computer-club gavels. Take the time to fully understand, as best as possible, the fine points of each major item you add to your computer system. Waiting a few nanoseconds now may save many endless loops later. ■

✓ Reader Service—see page 179

Depreciation Analysis

This program amplifies one that appeared back in the October 1978 issue (page 40).

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In the October 1978 issue of *Kilobaud*, John Musgrove introduced an article and program on depreciation ("Depreciation Calculations," p. 40). That article displayed an introductory aspect of depreciation. I now would like to take that idea further by giving more detail to the subject. The depreciation-analysis program presented here and the reference to accepted accounting principles and IRS regulations should give you a better understanding of depreciation.

Depreciation allows a business to systematically recover the cost of an asset for the purpose of replacement, subject to certain accounting restrictions and IRS regulations. There are three popular methods of depreciation that the program uses for comparison.

If you're a businessman, this program should aid your decisions about which method to use for your assets. If you're a hobbyist, the program may become a potential income producer for you. Every business has assets that depreciate. Many could probably use a comparative analysis to decide which method to use. You could provide this service to them for a fee.

Methods of Depreciation

First, let's take a look at the information needed to calculate depreciation.

- *Cost of the asset.* This may include the freight and setup charges, for example, as well as the purchase price.
- *Estimated useful life.* The period that the asset may be reasonably expected to be useful for the production of income (subject to IRS guidelines).
- *Salvage value.* The estimated amount that will be realized upon the sale or other disposition of the asset at the end of its useful life.

The three popular methods of depreciation used here are: (1) straight line, (2) sum of the year's digits and (3) declining balance (at twice the straight line rate). Of the three methods above, straight line is the easiest and probably most widely used. The last two methods are accelerated depreciation methods.

The accelerated depreciation methods carry some restrictions as to the type of assets that qualify. For example, an asset purchased used may not be depreciated at twice the straight line rate but may use a declining balance method at 1 1/2 times the straight line rate.

Regulations allow you to disregard up to 10 percent of the salvage value for IRS purposes, if the asset has a useful life of three or more years. IRS will allow you an additional first-year depreciation of 20 percent of the cost of the asset if the asset has a useful life of six or more years. This carries other stipulations and qualifications also.

This should give you a general overview of depreciation methods and their complexities. As you can see, depreciation is very complex, with many regulations and exceptions. As an example, IRS has a 40-page publication, *Publication 534*, dealing specifically with depreciation. Should you be in direct contact with a depreciation problem, I suggest you either obtain the IRS publication or consult an accountant.

The Program

This depreciation-analysis program was designed to compare the methods of depreciation and the results they produce. It conceivably is not accurate to the penny, nor does it allow for other than whole years of depreciation . . . the reason being that it is intended only for comparative purposes by which to base a decision.

The double-declining balance method is maximized by switching to the straight line method when the rate falls below the extended straight line rate. This is a generally accepted procedure.

The print statements (lines 250-268 and line 370) may need to be changed to suit your par-

```
                         * DEPRECIATION ANALYSIS *
         COST :  100000      USEFUL LIFE :  10 YRS.      SALVAGE :  5000

                 S. LINE                 S. YRS. DIGITS              DBL DEC BAL.
  YR        DEP.          BAL.        DEP.          BAL.         DEP.          BAL.
=================================================================================
   1      9500.00      90500.00    17100.00      82900.00     20000.00      80000.00
   2      9500.00      81000.00    15200.00      67700.00     16000.00      64000.00
   3      9500.00      71500.00    14250.00      53450.00     12800.00      51200.00
   4      9500.00      62000.00    12350.00      41100.00     10240.00      40960.00
   5      9500.00      52500.00    10450.00      30650.00      8192.00      32768.00
---------------------------------------------------------------------------------
   6      9500.00      43000.00     8550.00      22100.00      6553.60      26214.40
   7      9500.00      33500.00     6650.00      15450.00      5303.60      20910.80
   8      9500.00      24000.00     4750.00      10700.00      5303.60      15607.20
   9      9500.00      14500.00     3800.00       6900.00      5303.60      10303.60
  10      9500.00       5000.00     1900.00       5000.00      5303.60       5000.00
---------------------------------------------------------------------------------

=================================================================================

                         * DEPRECIATION ANALYSIS *
         COST :  2000       USEFUL LIFE :  8 YRS.      SALVAGE :  250

                 S. LINE                 S. YRS. DIGITS              DBL DEC BAL.
  YR        DEP.          BAL.        DEP.          BAL.         DEP.          BAL.
=================================================================================
   1       218.75       1781.25      385.00       1615.00       500.00       1500.00
   2       218.75       1562.50      332.50       1282.50       375.00       1125.00
   3       218.75       1343.75      297.50        985.00       281.25        843.75
   4       218.75       1125.00      245.00        740.00       210.94        632.81
   5       218.75        906.25      192.50        547.50       158.20        474.61
---------------------------------------------------------------------------------
   6       218.75        687.50      140.00        407.50       118.65        355.96
   7       218.75        468.75      105.00        302.50        88.99        266.97
   8       218.75        250.00       52.50        250.00        16.97        250.00

=================================================================================

                         * DEPRECIATION ANALYSIS *
         COST :  20000      USEFUL LIFE :  7 YRS.      SALVAGE :  2400

                 S. LINE                 S. YRS. DIGITS              DBL DEC BAL.
  YR        DEP.          BAL.        DEP.          BAL.         DEP.          BAL.
=================================================================================
   1      2514.29      17485.71     4400.00      15600.00      5800.00      14200.00
   2      2514.29      14971.42     3696.00      11904.00      4118.00      10082.00
   3      2514.29      12457.13     3168.00       8736.00      2923.78       7158.22
   4      2514.29       9942.84     2464.00       6272.00      2075.88       5082.34
   5      2514.29       7428.55     1936.00       4336.00      1473.88       3608.46
---------------------------------------------------------------------------------
   6      2514.29       4914.26     1232.00       3104.00      1046.45       2562.01
   7      2514.29       2400.00      704.00       2400.00       162.01       2400.00

=================================================================================
```

Sample run.

ticular system. The operator simply enters the requested information, and the program calculates and displays the three types of depreciation.

The program should lend itself well to any application you may have.■

```
2 '          ****************************************
3 '          *  DEPRECIATION COMPARISON ANALYSIS  *
4 '          *  AUTHOR :                          *
5 '          *       JOE LIGORI                   *
6 '          ****************************************
8 CLEAR 200
10 DEFDBL C,B:DEFINT I,Y
40 CLS:PRINT@276,"* DEPRECIATION COMPARISON *":PRINT
50 PRINT"ENTER THE FOLLOWING INFORMATION :":PRINT
60 PRINTTAB(15)"COST OF ASSET :";TAB(40);:INPUTC
70 PRINTTAB(15)"USEFUL LIFE IN YEARS"
80 PRINTTAB(15)"( WHOLE YEARS ONLY ) :";TAB(40);:INPUTY
90 PRINTTAB(15)"SALVAGE VALUE :";TAB(40);:INPUTS:PRINT
110 PRINTTAB(10)"PRESS < ENTER > FOR COMPARISON CHART ...";
112 INPUT Q$
179 '********* SET ALL BALANCES TO COST *********
180      B1=C:B2=C:B3=C
199 '**********  SET UP SUM OF YEARS DIGITS  ***********
200    T=0
202      FOR I = 1 TO Y
204      T=T+I
206      NEXT I
208 '*********  SET UP DOUBLE DECLINING BALANCE PERCENTAGE  **
210      P=(1/Y)*2
212      P=(P+.005)*100:P=INT(P)/100
218 ' ******** SET UP STRAIGHT LINE AMOUNT ********
220      D1=(C-S)/Y
222      D1=(D1+.005)*100:D1=INT(D1)/100
249 '*******  PRINT SPECIFIERS  *******
250   L$="##  #####.## ######.##  #####.## ######.##  #####.## ######.##"
260 CLS
262 PRINT"        COST : ";C;"     USEFUL LIFE : ";Y;"     SALVAGE : ";S
264 PRINTTAB(20)STRING$(24,"-")
266 PRINT"            S. LINE          S. YRS. DIGITS        DBL DEC BAL."
267 PRINT"        DEP        BAL        DEP         BAL        DEP       BAL"
268 PRINTSTRING$(63,"=")
299 '****** WORKING LOOP *********
300      FOR I = 1 TO Y
302         B1=B1-D1
304         IFB1-S<.05 THEN B1=S
312         A=(Y-(I-1))/T:A=(A+.005)*100
320         A=INT(A)/100:D2=A*(C-S)
322         IF B2-D2<S THEN D2=B2-S
324         B2=B2-D2
328         IF F=1 GOTO 360
330         IF B3 <= S THEN D3=0 : B3=S : GOTO 370
340         D3=B3*P
342         SW=(B3-S)/(Y-(I-1))
344         IF D3<SW THEN D3=SW:F=1:GOTO 360
350         IF B3-D3<S THEN D3=B3-S
360         B3=B3-D3
370         PRINTUSINGL$;I,D1,B1,D2,B2,D3,B3
380         IFI/10 <> INT(I/10) GOTO 400
390         INPUT"PRESS < ENTER > TO CONTINUE ";Q$
400      NEXT I
410 INPUT"*** DO YOU WANT ANOTHER ANALYSIS ";Q$
420 IF LEFT$(Q$,1)="Y" THEN RUN
430 END
3000 '
3002 '
3004 '
3006 '=========================================================
3008 '
3010 '
3012 '
5000 '     ********************************************
5010 '                VARIABLE NAME CHART
5020 '     ********************************************
5030 '     NAME          FUNCTION
5031 '     -----         ---------
5040 '      A        SUM OF YRS. DIGITS PERCENTAGE
5050 '     B1        STRAIGHT LINE METHOD BALANCE
5052 '     B2        SUM OF YRS. DIGITS METHOD BALANCE
5054 '     B3        DBL. DECLINING BALANCE METHOD BALANCE
5060 '      C        COST OF ASSET
5070 '     D1        STRAIGHT LINE METHOD DEPRECIATION
5080 '     D2        SUM OF YRS. DIGITS METHOD DEPRECIATION
5100 '     D3        DBL. DECLINING BALANCE METHOD DEPRECIATION
5102 '      F        FLAG : SET IF D.D.B. IS SWITCHED TO S.L.
5110 '      P        DOUBLE DECLINING BALANCE METHOD PERCENTAGE
5120 '      S        SALVAGE VALUE
5122 '     SW        CALCULATES S.L. RATE TO COMPARE TO D.D.B.
5130 '      T        SUM OF YEARS
5140 '      Y        NO. OF YEARS TO DEPRECIATE ASSET
5150 '     ***************************************
5152 '
5160 '     MAXIMIZATION IS TAKEN IN DBL. DECLINING BALANCE
5170 '     METHOD BY SWITCHING TO STRAIGHT LINE DEPRECIATION
5180 '     RATE AT OPTIMUM TIME.
```

Program listing.

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Twin Cassettes for Your TRS-80

Dual cassettes can go a long way toward easing your data-handling woes. Try this $35 interface for your TRS-80.

Have you ever experienced the sense of satisfaction that comes with finally discovering the "proper tool" that allows a difficult chore to be accomplished with ease? If so, you should be able to appreciate this article. Almost anything is easy once you get the hang of it. But more often than not, the "hang" simply turns out to be the right tool for the job. Of course, it has to exist first. Then it has to be within your budget.

If you are not yet aware of the advantages that dual cassette capability has to offer, you will learn when you start creating programs that involve data files. Radio Shack Level II BASIC and its Expansion Unit will provide this capability at a cost of about $400, not including the extra recorder.

Photo 1. An attempt was made at "human-engineering" the interface's front panel. Components are grouped by function with the ones most used closest to the operator. Push buttons (green for READ, red for WRITE) are used to position or rewind tapes and match the colored labels on the recorders they run. A red/green LED between them indicates which recorder is running under computer control. A yellow LED is a visual indicator of data and is located above a jack for earphone or scope monitoring of data.

When I first needed dual cassettes, neither item was available. So I designed and built my unit including some features Radio Shack doesn't provide. It has indeed turned out to be the "proper" tool for the job. If you can build from a schematic, you can "roll your own" for about $35 worth of readily available parts.

Description

There are absolutely no modifications of any kind to make to the TRS-80. The interface is simply plugged into the computer's TAPE jack via a cable with 5-pin DIN plugs on both ends (see Fig. 2). The recorder cable received with the computer may be used to connect the interface to the READ recorder. A new cable must be made to connect the interface to the WRITE recorder. Finally, a simple 2-wire cable connects the separate power supply. The interface operates on +5 volts at about 135 milliamperes of current. It is *not* recommended that +5 volts from the computer's expansion port be used, especially if you have, or plan to have, 16K memory or Level II BASIC installed. You can build a simple power supply (see Fig. 3) for as little as $8 and not only supply power for this project but have enough in reserve for future additions as well.

The recorders are switched on and off by power transistors, which are more reliable than relays. They are powered by the recorders they control since op-

tical couplers are used for electrical isolation from the rest of the interface.

A pair of push buttons in parallel with the power transistors are used for independent manual control of each recorder to rewind tapes or advance them in fast-forward (see Photo 1). This is one feature that Radio Shack does not provide, and it eliminates the necessity of constantly unplugging the remote cable.

Most of the time, one recorder will be used in PLAY and the other in RECORD. This allows the computer to "read" data from one recorder and "write" data onto tape in the other recorder. The interface unit will automatically turn on only the proper recorder and leave the other one off. Such a capability is essential when many read and write operations are intermixed, for example, as in updating a long data file that must be done one record at a time.

Selection of the proper recorder is accomplished by a sensing circuit that monitors the output data line from the computer. When a cassette command is executed by the computer, the WRITE recorder is turned on if output data is sensed, or the READ recorder if no data is sensed. Also, a unique two-color light emitting diode (LED) glows red during a WRITE operation or green during a READ operation. Otherwise, it is a frosty neutral color.

Another LED (yellow) glows when data is actually coming out of the READ recorder at the proper level. It is operated by a separate sensing circuit with adjustable sensitivity. It is particularly useful in locating the exact beginning or end of programs in the middle of a tape because it works whenever the recorder is running—manually or under computer control.

This visual data monitor is another useful feature that is not provided by Radio Shack, but it can sure be a timesaver when cassettes are used. If you prefer, a miniature phone jack can also be used to monitor recorder output data with an earphone or an oscilloscope. You can use an oscilloscope to determine if tape heads are dirty or worn—or for other recorder maintenance.

Another important feature is provided by a toggle switch used to select whether one or both recorders will turn on for a "write" operation. With Level I BASIC, the only way to verify that a program has been recorded without errors is by reloading it back into the computer; this destroys the original program in memory.

The only sure way to keep from losing a program in case a defective tape is encountered is to record it twice on different cassettes. The "dual write" feature allows this to be done on both recorders simultaneously to save time.

The biggest single advantage of this particular dual cassette interface unit is its low cost. It doesn't need special software commands so it works perfectly well on existing Radio Shack Level I BASIC. Existing programs don't have to be rewritten. It will also work with Level II BASIC, which has a faster data transfer rate.

Almost all of the parts are available in local electronic stores, although they will gen-

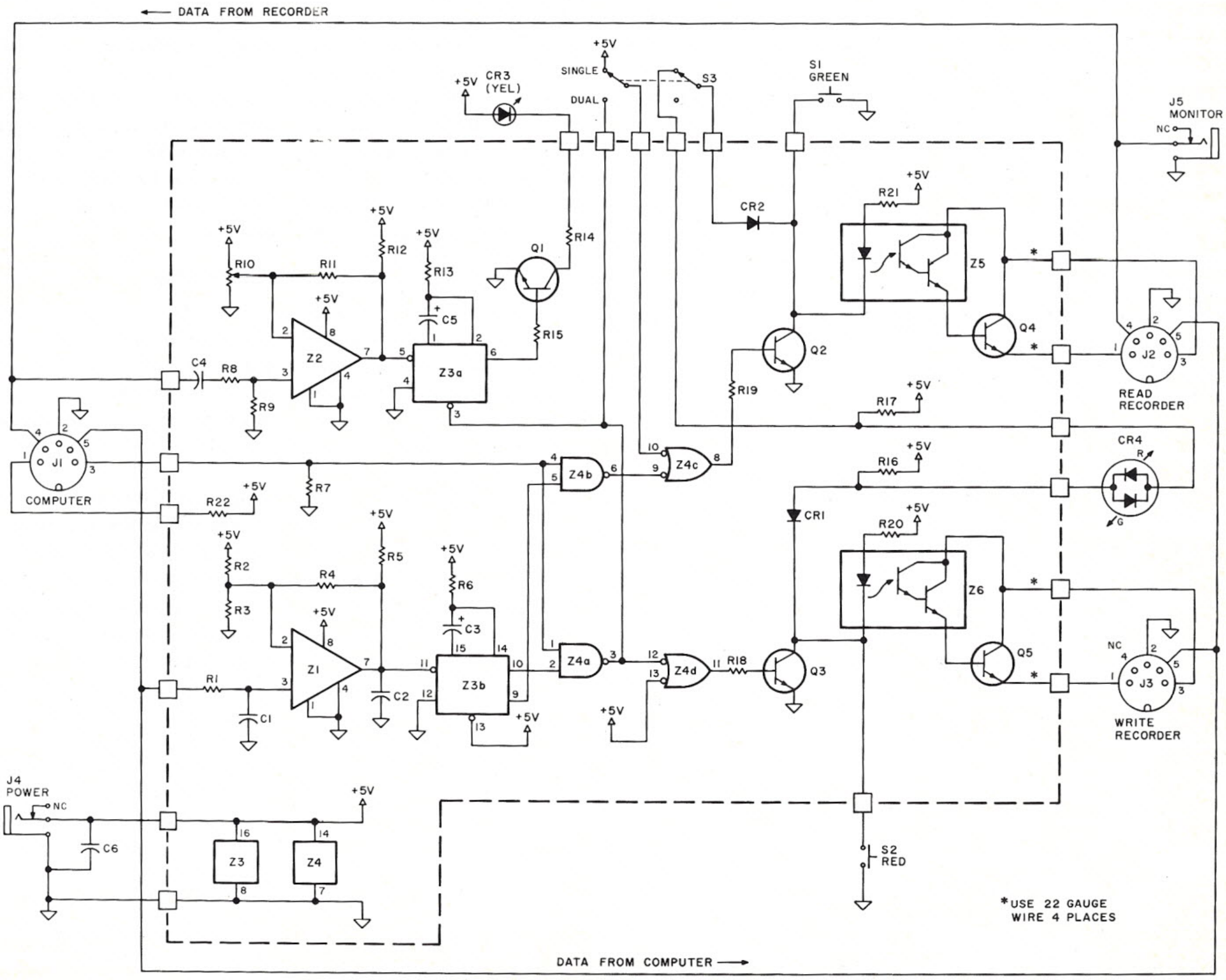


Fig. 1. Schematic diagram of the Automatic Dual Cassette Interface Unit for use with the TRS-80.

erally cost less if ordered through mail-order houses that advertise in the back of this magazine. You will probably have to get some of the parts from these sources anyway.

Circuit Operation

The computer's TAPE jack is connected through shielded audio cables to the same type of 5-pin jack, J1, on the interface unit (see Fig. 1). Identical jacks are also used for J2 and J3 to the recorders so that pin designations for all the connectors are the same as those used by Radio Shack to identify functions on the TAPE jack. There is no possibility of causing damage by plugging into the wrong jack.

When the computer executes a cassette input or output command, its relay completes a circuit between pins 1 and 3 of J1 to apply a logic high to both Z4A and Z4B. This will enable one or the other depending on the state of Z3B's complementary outputs. Normally, Z3B pin 10 is low and pin 9 is high. These outputs remain unchanged during a "read" operation, so only Z4B will be enabled.

A "write" operation is distinguishable from a "read" operation because data pulses to be written onto tape from the computer will be present on J1 pin 5. Each of these data pulses will be detected and amplified by voltage comparator Z1 to trigger monostable multivibrator Z3B.

The values of R6 and C3 determine that Z3B will output a high on pin 10 and a low on pin 9 for 11 milliseconds following each trigger. The data pulses, only 0.25 milliseconds in duration, represent binary information by occurring either 2 or 4 milliseconds apart (1 or 2 milliseconds with Level II BASIC). So Z3B is continuously being retriggered before each 11-millisecond time period elapses. Therefore, its output pin 10 remains high, keeping Z4A enabled as long as there are data pulses to be written onto tape.

When Z4A is enabled, the low from its output is inverted in Z4D to turn on transistor Q3. Electron current from Q3's collector flows to +5 volts through two paths. One is through the LED in optical coupler Z6 and R20. Light from the LED switches on the phototransistor Darlington circuit inside the coupler. This causes Q5 to conduct, which completes a circuit between pins 1 and 3 of J3 allowing the WRITE recorder to run.

The other path current takes from the collector of Q3 is through CR1, CR4 and R17. CR4 is the two-color LED, which is actually a red LED and a green LED in parallel with reverse polarity. In this case, current flows through the red LED to indicate a "write" condition, and the green LED is off because it is reverse biased.

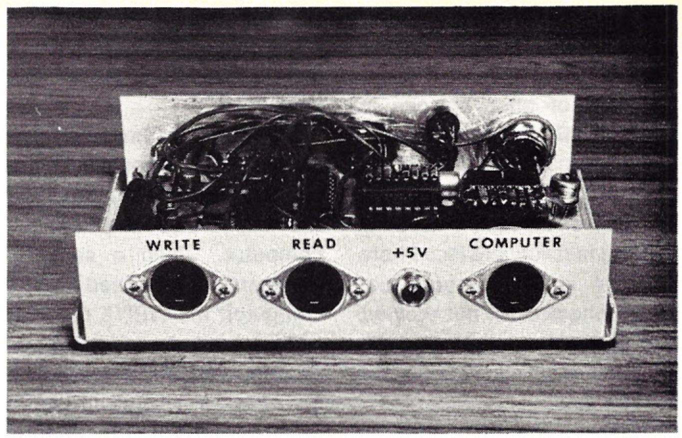


Photo 2. The rear panel is where connectors are located for input, output and 5 volt dc power. This prototype version shows the rat's nest of wires inside that results if the ribbon cable (shown in Photo 3) is not used.

In the "read" mode of operation, there are no data pulses from the computer to trigger Z3B, so Z4B is enabled instead of Z4A. Z4C, Q2, Z5 (with R21) and CR4 (with CR2 and R16) operate the same as their counterparts in the "write" circuit. Only now the READ recorder is turned on, and the green LED in CR4 indicates this.

S3 is used to select the "dual write" feature by causing the output from Z4A during a "write" operation to enable Z4C as well as Z4D. Therefore, both couplers are activated and both recorders will run. However, only the red LED in CR4 will light because the green LED is disabled with another section of S3.

The data line from the output of the READ recorder to the computer is monitored by voltage comparator Z2. It operates similar to Z1 except that its sensitivity is adjustable with R10. When data pulses are detected, they are amplified and used to trigger Z3A, which operates similar to Z3B. The high output turns on Q1 causing current to flow in CR1, the yellow LED indicator.

Construction

The circuit is constructed on a perfboard with 0.1 inch hole spacing to accommodate nine wire-wrap sockets, the two power transistors, Q4 and Q5, the pot R10 and timing capacitors C3 and C5. It is housed, minus the power supply, in an LMB mini-box (No. 139) measuring 5 1/2 × 3 × 1 1/2 inches. Four connectors are located on the rear for the power supply input, the computer and the two recorders (see Photo 2).

Cut the perfboard to 2×5 inches and install the 16-pin wire-wrap sockets. Leave room for mounting screws. Install the ICs and power transistors. Install discrete components on Cambion component socket adapters to plug into the three wire-wrap sockets. Let the larger components hang over one side to maintain a low profile. Then wire up the sockets according to the schematic in

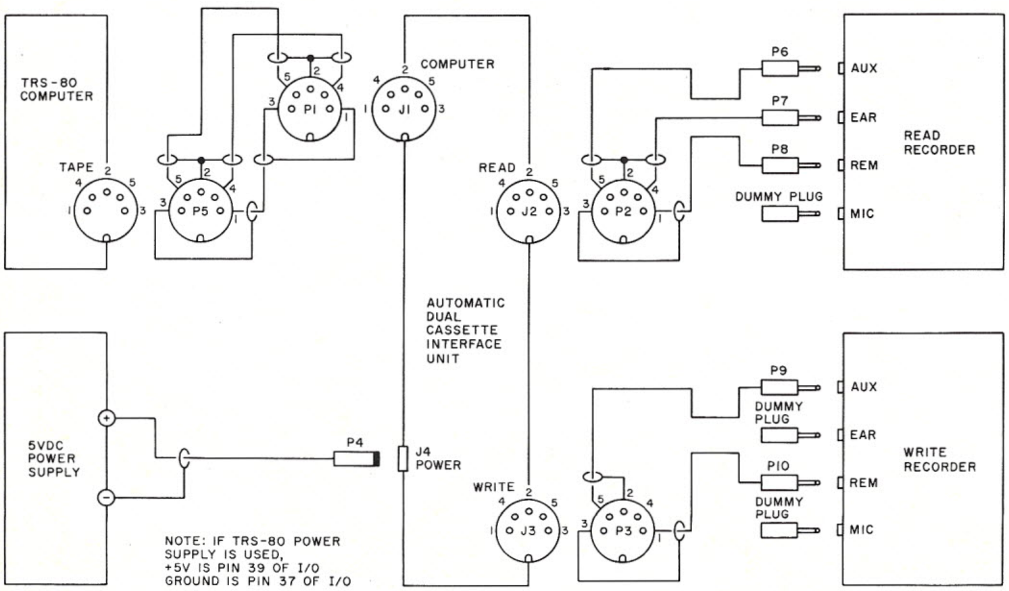


Fig. 2. Interconnecting wiring diagram.

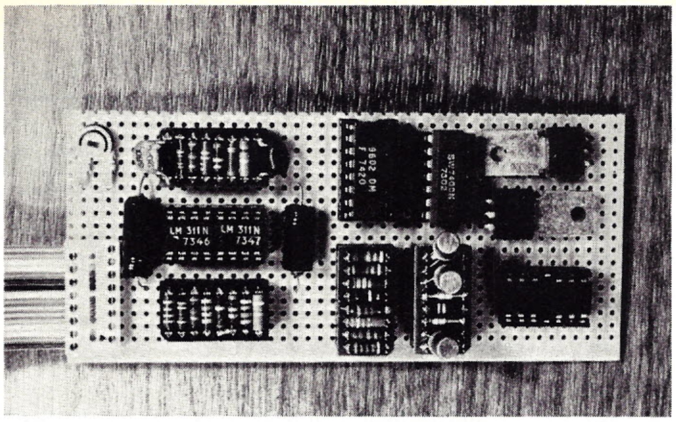


Photo 3. Internal components plug into IC sockets with wire-wrap pins. Resistors, diodes and the three small transistors are installed on plug-in socket adapters. One socket serves as a connector for a DIP plug with a ribbon cable wired to the front and rear panel-mounted components.

Fig. 2, letting one socket be a connector (see also Photo 3).

I highly recommend the use of Vector's Slit 'N Wrap tool because it does the neatest, fastest and most professional-looking job and is easier to master by even the most inexperienced of builders. It is self-contained including wire, and there are no extras such as stripping tools to buy. Conventional soldering techniques will have to be used in a couple of places such as on the power transistors and, of course, the panel-mounted components. Be sure to use heat sinks when soldering to the LEDs.

A pre-wired DIP plug makes interconnection between the perfboard and panel-mounted components fast and neat. It just plugs into the socket designated as a connector for this purpose, while the wires from it are separated and cut where necessary to solder to the panel-mounted components. As an alternative, another component socket adapter can be wired up as a plug.

After the perfboard is wired, the excess socket leads must be clipped off so it will fit in the enclosure. Be sure the remaining leads don't touch the cover when it is installed.

The best way to make the recorder interface cables is with store-bought pre-wired cables with molded-on miniature and subminiature phone plugs. They will last much longer than ones you would make up yourself. Buy them in 36 inch lengths and cut in half to install the 5-pin DIN plugs. The cable between J1 and the computer will have DIN plugs on both ends. Make this one twice as long (or more if needed) and use shielded audio cable or RG-174 coaxial cable, which is easier to work with.

The two-color LED, also known as a bipolar LED, is Monsanto's MV5491 or equivalent. Individual red and green LEDs can be used instead by simply wiring them in parallel, but with opposite ends together.

Also, you can make your own optical couplers for Z5 and Z6. Install an LED and a photocell, photo-diode or photo-transistor in a small tube or other enclosure and wrap with electrical tape to keep out light. You may have to do some experimenting to get the right combination, but speed performance is not critical. The object is to get the power transistor to turn on a recorder.

Z1 and Z2 are type 311 voltage comparators, which come in both 8-pin and 14-pin DIP versions. Fig. 2 shows the 8-pin version pin numbers because it is smaller and both units will fit in a single IC socket.

The red for WRITE and green for READ color code of the recorders designations are used for the two-color LED, the button colors of the manual push buttons and should be continued with colored labels to attach to the recorders. The color coding may seem a trivial point but it serves to prevent silly mistakes when you are concentrating on other details.

If you don't buy colored push buttons, you should either paint the buttons or use a hole punch

C1, C2—680 pF
C3, C5—5 uF, 25 volts electrolytic
C4—.01 uF
C6—.05 uF
CR1, CR2—1N4148
CR3—XC5023Y yellow LED or equiv.
CR4—MV5491 two-color LED
J1, J2, J3—5-pin DIN socket
J4—power supply jack
J5—miniature phone jack
P1, P2, P3, P5—5-pin DIN plug
P4—power supply plug
P6, P7, P9—miniature phone plug
P8, P10—subminiature phone plug
Q1, Q2, Q3—2N2222
Q4, Q5—D40D1 or equiv. (SK3054)
ALL RESISTORS ARE 1/4 W 5% UNLESS OTHERWISE NOTED.
R1, R8—10,000 Ohms
R2—6,800 Ohms
R3, R7, R15, R18, R19—1,000 Ohms
R4, R11—390,000 Ohms
R5, R12—100,000 Ohms
R6, R9, R13—6,200 Ohms
R10—10,000 Ohm pot.
R14, R22—100 Ohms
R16—100 Ohms, 1/2 Watt
R17, R20, R21—150 Ohms, 1/2 Watt
S1, S2—SPST N.O. momentary push-button switch
S3—DPDT miniature toggle switch
Z1, Z2—LM311N (8-pin mini-dip version)
Z3—9602
Z4—7400
Z5, Z6—H11B1 photo Darlington coupler or equiv.
Misc: enclosure (LMB 139 or larger), 0.1" perfboard, wire-wrap IC sockets, component mounting adapters, shielded audio cable, wire, hardware, etc.

Table 1. Parts list.

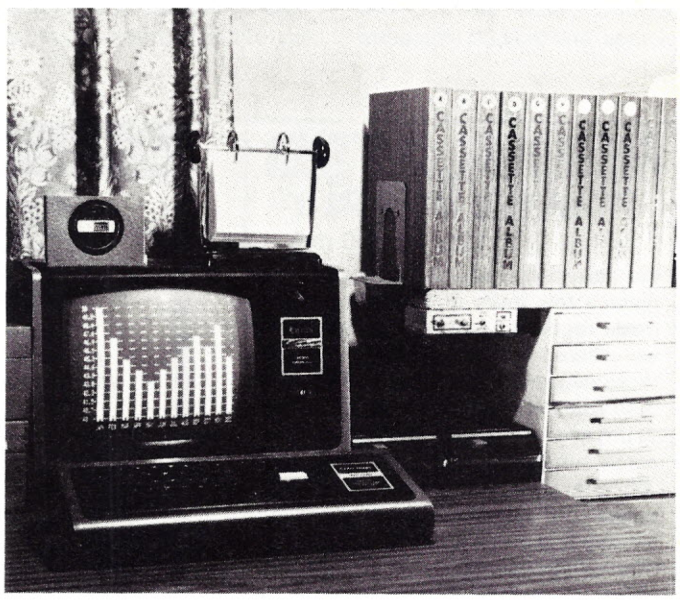


Photo 4. The author's installation is neat and easy to use. The interface unit is at eye level, within easy reach but up, out of the way, and firmly attached so it doesn't slide around. The 5 volt power supply is behind the display.

Photo 5. The interface unit, 5 volt dc power supply and cables.

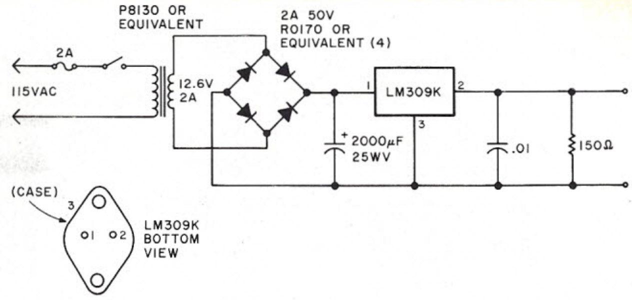


Fig. 3. Schematic diagram of 5 volt dc power supply.

to make adhesive disks out of colored plastic tape or label-embossing tape. The recorder labels can be made with red and green embossed tape also. If you want a more professional appearance, go to a drafting supply store and ask for 3M Company's I.N.T. material. It uses a simple photo process you can do at home.

Installation

My interface unit is mounted to the underside of a shelf directly above the two recorders (see Photo 4). That way it is easily accessible, doesn't slide around when buttons are pushed, and the LED indicators are at eye level for easy viewing. The unit is in the immediate vicinity of both recorders, yet up off the bench surface to keep it clutter free. That allows more room for notes, flowcharts, etc. The cables exiting from the rear are out of sight under the shelf, giving the installation an extremely neat appearance.

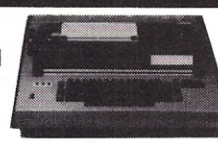
The power supply is located next to the TRS-80 power supply behind the video display out of sight. It was not built-in to the interface unit because the enclosure would be excessively large and look out of place (see Photo 5). Besides, it is a good idea to keep high voltage (115 V ac) away from ICs and the magnetic field from the transformer away from the vicinity of cassettes. In addition, my power supply will serve as a central unit to provide power for other computer projects I am planning.

The power supply shown in Fig. 3 uses a 12 volt 2 Amp filament transformer. The LM309K is a 1 Amp power regulator IC, which is highly regulated, extremely reliable and includes both temperature compensation and short-circuit protection. Those features make this power supply well worth its low cost, even if you don't need the extra current capability right now; you may need it for something else later.

Conclusion

Keep in mind that this project is not a kit, so you are free to add, delete, modify, substitute or rearrange to suit yourself. Decide beforehand where you intend to place it and whether it will be mounted underneath a shelf, as I described, or on a surface such as your desk. It makes a difference in the type of enclosure you use and where you mount the controls and LEDs. Label the panel with dry transfer letters and apply a protective coat of clear lacquer before mounting any components. Be careful when soldering so semiconductors are not damaged by heat or resistors don't change value from overheating. Above all, take your time!

If you are not an experienced builder, use a larger enclosure to give yourself plenty of room to work in. For those of you who are not builders or don't have the time, the interface unit and power supply are manufactured and sold by Sel-Tronics, Inc., 721 Ellsworth Dr., Silver Spring MD 20910, for $69.95, assembled and tested, plus $2 shipping and a Maryland tax for residents of that state. ■



Reader Service—see page 179

SPINTERM T.M.

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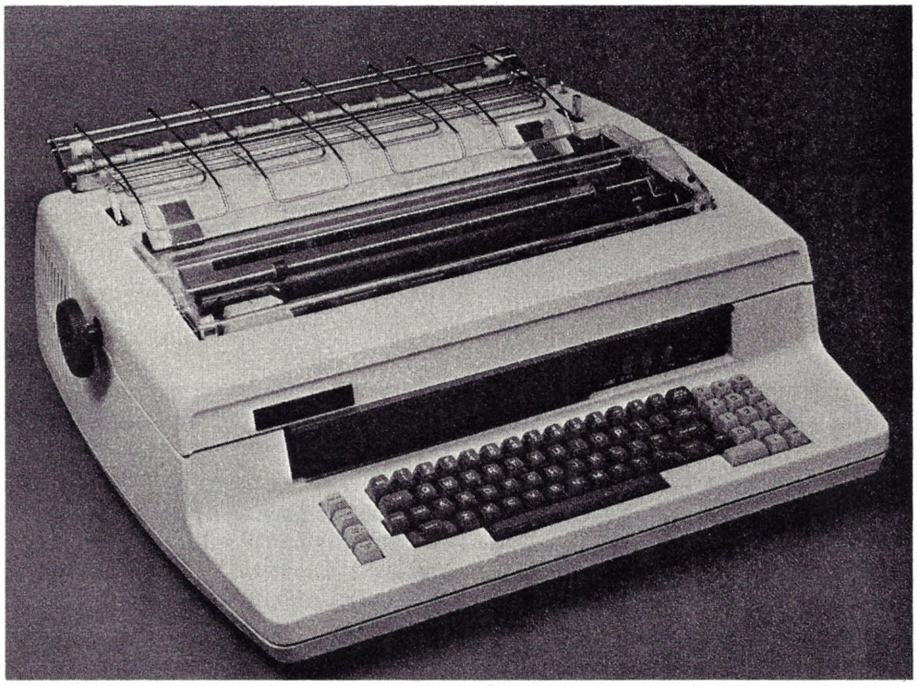

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SPINTERM

✓130

✓ Reader Service—see page 179

Bar-Graph Generator

A useful program for people who want graphing information without learning statistics.

Frederick E. Luffman
3701 Station Street
Sacramento CA 95826

Of the many available techniques that are used for the display of information, one of the most meaningful and easy to grasp, especially for the nontechnical person, is the bar graph. Bar graphs are used extensively in business, science and engineering and also in the area of statistical analysis where they are commonly known as histograms.

Using the Bar-Graph Generator

Learning to use the program listing is a fairly straightforward procedure and, with a little practice, becomes quite easy. The data statements, which start at line 3000, are, for the most part, self-explanatory. Statements 3000 and 3005 contain the title and x and y axis labels, respectively. In statement 3010, other program variables are defined. These variables are:

1. N—the number of data values to be plotted.
2. C—column in which plotting will start.
3. S—spacing between bars.
4. MN—minimum value on scale.
5. MX—maximum value on scale.

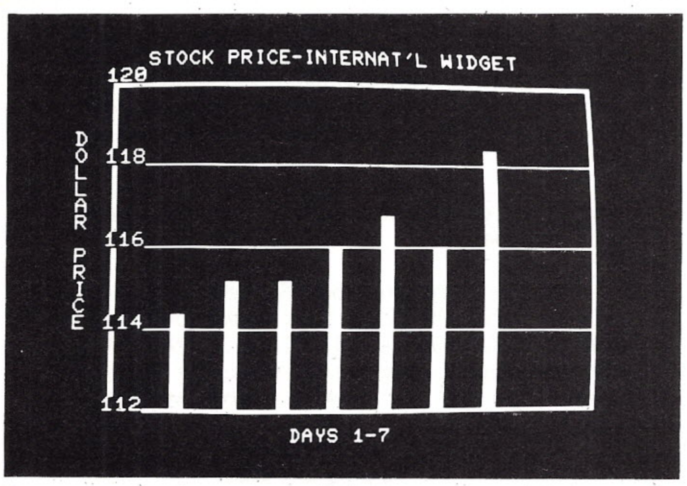
The last two data statements contain the actual scale markings and the data to be plotted.

As an example of scaling data values, let's look at Example 1, which shows the price of a certain stock on a daily basis. We should decide on a range in which we will plot out data. This range, characterized by a minimum and maximum value (MN and MX), will be used to adjust our data values to correspond to the vertical height of the graph (a range of 0-20).

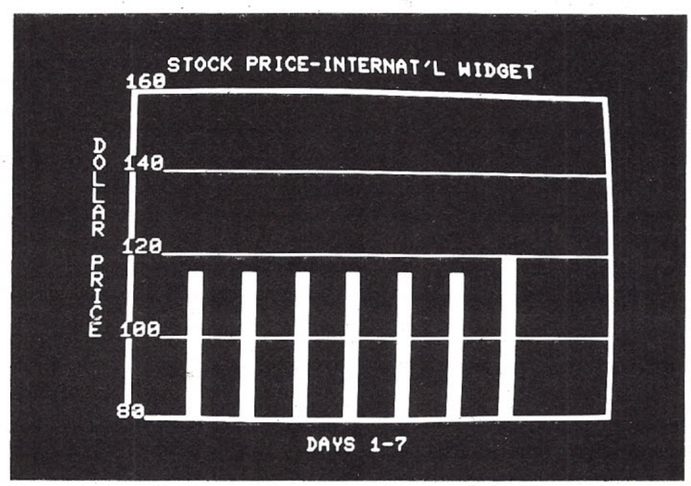
The method by which this is accomplished is listed starting

Day	Price
101	$114.26
102	115.10
103	115.30
104	116.00
105	116.75
106	116.00
107	118.33

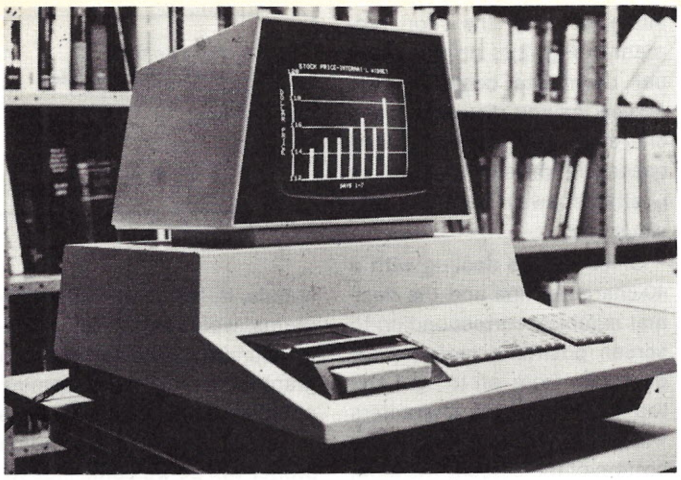
Example 1.



High-resolution plot using PET graphics.



Low-resolution bar graph.



The author's PET at work.

		COLUMN				
		1	2	•	•	40
ROW	1	32768	32769			32807
	2	•••••	•••••			
	•					
	25	33728	•••••		33766	33767

Fig. 1.

at line 2500. It is at this point that some good guesswork is in order since if we increase the range, we decrease the resolution of the plot and vice versa. If you anticipate wanting to be able to compare plots generated over a long period of time, it might be a good idea to sacrifice some resolution in order to gain a consistent scale without the danger of going off scale with unanticipated variations in the data values.

If a particular plot happens to be one of a kind, then a high-resolution scale will perhaps be in order. In the example included in the program listing this is the case. The entire scale only covers a range of $8.

The Program

The bar-graph plotter makes use of the graphics of the PET computer, although its basic principle should make it adaptable to any machine equipped with graphics. Required program memory is only about 2K bytes.

There are two ways to create a picture on the screen of the PET, and this program makes use of both. The first and probably the most commonly used method requires that the program place the cursor at the position in which the character is to be printed.

This technique usually calls for two print statements—one to move the cursor and one to print the character. Most of the time one or both of these statements will be part of a FOR-NEXT loop. This method is useful whenever we wish to print a string of nonidentical characters whose composition is allowed to vary. This technique is utilized in the program in the subroutines found on lines 1500 and 2000 and should be usable on any machine equipped with programmable cursor control.

The second method uses that area of RAM in the PET from which the screen is refreshed. Since the PET has a 25 × 40 character format, there are 1000 possible positions in which a character may be written. The screen may be fully described by the 1000 bytes in RAM that correspond to the 1000 possible positions on the screen. This scheme is illustrated in Fig. 1 with the actual RAM locations given in decimal format.

As a simple example concerning the use of this tech-

Program listing.

```
90 REM *SIMPLE BAR GRAPH PLOTTER
92 REM *5/2/78 F.E. LUFFMAN
94 REM *N(# BARS);C(BEGINNING COLUMN);H (HEIGHT)
96 REM *S(SPACE BET. BARS)
97 REM *MX(MAX EXPECTED VALUE)
98 REM *MN(MIN EXPECTED VALUE)
99 DIM X$(40),Y$(24),T$(40)
100 READ T$,X$,Y$
110 READ N,C,S,MN,MX
112 S=S+1
114 C=C+1
115 GOSUB 1000:GOSUB 1500:GOSUB 2000
117 REM
118 REM *** MAIN LOOP ***
119 REM
120 FOR I=0 TO N-1
130 READ H
132 GOSUB 2500
135 IF H<=0 THEN 150
140 GOSUB 200
150 NEXT I
160 GET A$:IF A$="" THEN 160
165 END
190 REM
195 REM *** PLOT COLUMNS ***
198 REM
200 COL=32768+I*S+C
210 H=23-H
220 FOR J=H TO 22
230 POKE (COL+J*40),160
240 NEXT J
250 RETURN
990 REM
995 REM *** PRINT BORDERS ***
998 REM
1000 PRINT "CS"
1010 FOR K=0 TO 19
1020 POKE (32890+K*40),118
1025 POKE (32927+K*40),116
1030 NEXT K
1040 FOR L=1 TO 36
1050 POKE (33650+L),111
1060 POKE (32890+L),119
1070 NEXT L
1074 REM
1075 REM *** PRINT GRADUATIONS ***
1078 REM
1080 FOR M=5 TO 15 STEP 5
1090 FOR P=1 TO 36
1100 POKE 33650-40*M+P,100
1110 NEXT P: NEXT M
1195 REM
1200 REM *** PRINT TITLE ***
1205 REM
1500 PRINT "CH"
1510 L=(40-LEN(T$))/2
1520 FOR T=1 TO L:PRINT "CR";
1525 NEXT T
1530 PRINT T$;
1540 RETURN
1995 REM
2000 REM *** PRINT X AXIS LABEL ***
2002 REM
2005 PRINT "CH"
2010 FOR X=1 TO 24:PRINT"CD";:NEXT X
2015 L=(40-LEN(X$))/2
2020 FOR X=1 TO L:PRINT"CR";:NEXT X
2025 PRINTX$;
2085 REM
2090 REM *** PRINT Y AXIS LABEL ***
2095 REM
2100 PRINT"CH";
2102 N1=1
2105 L=(24-LEN(Y$))/2
2110 FOR Y=1 TO L:PRINT"CD";:NEXT Y
2115 FOR Y=1 TO LEN(Y$)
2120 PRINT MID$(Y$,N1,1)
2125 N1=N1+1:NEXT Y
2190 REM
2192 REM *** LABEL SCALE ***
2194 REM
2200 PRINT "CH";"CR";
2210 I1=2
2220 FOR I=1 TO I1
2230 PRINT "CD";:NEXT I
2240 READ G:PRINT G
2250 PRINT "CH";"CR";
2260 I1=I1+5
2270 IF I1=27 THEN RETURN
```

```
2280 GOTO 2220
2495 REM
2496 REM *** CALCULATE SCALE FACTOR ***
2497 REM
2500 H=20*(H-MN)/(MX-MN)
2510 IF H-INT(H)<.5 THEN 2530
2520 H=INT(H)+1:RETURN
2530 H=INT(H):RETURN
2950 REM
3000 DATA "STOCK PRICE-INTERNAT'L WIDGET"
3005 DATA "DAYS 1-7","DOLLAR PRICE"
3010 DATA 7,6,3,112,120
3012 DATA 120,118,116,114,112
3015 DATA 114.26,115.1,115.3,116,116.75 ,116,118.33
4000 END
4900 REM
4950 REM
5000 REM ** CURSOR MOVEMENT KEY **
5010 REM CS-CLEAR SCREEN:CU-CURSOR UP
5020 REM CL-CURSOR LFT.:CR-CURSOR RHT.
5030 REM CD-CURSOR DOWN:CH-CURSOR HOME
```

Since no printer as yet will print out the PET cursor movements, I've taken the liberty of typing in the correct cursor movements according to the legend at the end of the listing.

nique, consider the short program in Fig. 2 to print a white bar down the center of the screen. As you may note, each character (160 = reverse field space) is printed exactly 40 positions away from the previous one.

```
10 FOR I=0 TO 24
20 POKE 32788 + 40*I,160
30 NEXT I
40 END
```

Fig. 2.

Since we are dealing with a 40-character line and the decimal numbers corresponding to screen positions increase sequentially from left to right and top to bottom, the characters will stack up from the top to the bottom of the screen. The bars, the graph borders and the graduations are printed in this manner.

Although this bar-graph generator is quite useful as it stands, it, like many other programs, would be enhanced immeasurably by the addition of a graphics printer. The coming addition to the Commodore line of a full graphics 80-column printer will be welcome indeed. After all, who can guess what wonderful things have passed into oblivion by the simple pressing of a button called "clear screen!" ■

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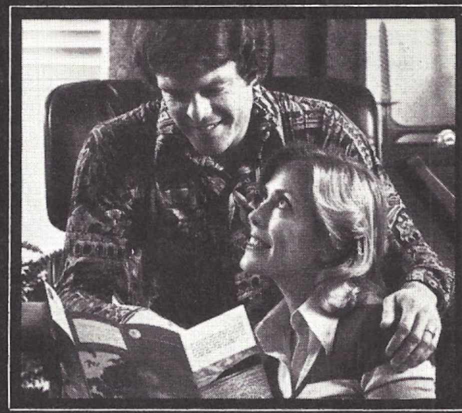

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Let's Have Some Order

Organization is easy with this quickie alphabetization program.

If you are ever assigned the chore of arranging a list of names in alphabetical order for the annual office party, a bowling banquet or tournament, or for any other reason, this program will simplify the project.

Alphabetizing a list of ten items isn't too difficult, but once the number goes beyond that, it becomes a real task.

This program runs in 8K BASIC on my SWTP machine. I adapted it from the Alphabetize program in the book *Some Common BASIC Programs* by Lon Poole and Mary Borchers, published by Osborne & Associates, Inc. I modified the program to number the list, as well as place the items in alphabetical order.

As written, the program will number up to 99 items, keeping the first letter in each entry in line. If over 99 items are ordered, then lines 200 to 220 should be changed as follows:

```
200 IF I<10 THEN T=3
210 IF I>9  THEN T=2
215 IF I>99 THEN T=1
```

The DIM statement in line 40 should contain the number of items you are going to alphabetize, especially if you are short on computer memory. For example, line 40 is DIM A$(13) if you are ordering 13 items.

If you are using the SWTP BASIC, a slight problem arises when it tests for string equality. This is pointed out by Rich Didday in his article "A Tale of Four BASICs" (see *Kilobaud*, January 1978, p. 50). The name Smithy would be incorrectly placed before Smith. This, of course, does not happen often and if it does, it is a simple matter to rearrange the few names after the majority of the items are ordered.

The next time your group has to alphabetize a list of people, you can volunteer for the project. The members will praise you for your hours (?) of hard work! ■

```
  1 REM * ADAPTED FROM THE BOOK 'SOME COMMON BASIC PROGRAMS' *
  2 REM * BY LON POOLE AND MARY BORCHERS *
  3 REM * PUBLISHED BY OSBORNE & ASSOCIATES, INC. *
 10 PRINT TAB(20);"ALPHABETIZE"
 20 PRINT:PRINT:PRINT
 30 INPUT "HOW MANY ITEMS ARE THERE TO BE ALPHABETIZED ",N
 40 DIM A$(100)
 50 FOR I=1 TO N
 60 PRINT "ENTER ITEM NO. ";I;
 70 INPUT A$(I)
 80 NEXT I
 90 FOR I= 1 TO N
100 FOR J= 1 TO N-I
110 LET A$ = A$(J)
120 LET B$ = A$(J+1)
130 IF A$ < B$ THEN 160
140 LET A$(J) = B$
150 LET A$(J+1) = A$
160 NEXT J
170 NEXT I
180 PRINT:PRINT
190 FOR I = 1 TO N
200 IF I < 10 THEN T=2
210 IF I > 9 THEN T=1
220 PRINT TAB(T);I;"";A$(I)
230 NEXT I
999 END
```

Program listing.

```
                    ALPHABETIZE

HOW MANY ITEMS ARE THERE TO BE ALPHABETIZED ? 10
ENTER ITEM NO. 1 ? JAMES
ENTER ITEM NO. 2 ? FISHER
ENTER ITEM NO. 3 ? HUNTER
ENTER ITEM NO. 4 ? KUHMAN
ENTER ITEM NO. 5 ? CRAIG
ENTER ITEM NO. 6 ? DEHART
ENTER ITEM NO. 7 ? KITMAN
ENTER ITEM NO. 8 ? MARKS
ENTER ITEM NO. 9 ? TROUGHTON
ENTER ITEM NO. 10 ? HANSEN


 1 CRAIG
 2 DEHART
 3 FISHER
 4 HANSEN
 5 HUNTER
 6 JAMES
 7 KITMAN
 8 KUHMAN
 9 MARKS
10 TROUGHTON

READY
#
```

Sample run (user input is underlined).

✔ Reader Service—see page 179

Quicksort!

Many microcomputer applications require the sorting and ordering of data. Quicksort offers a new approach to this problem.

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This article was inspired by Thomas Doyle's article, "5 Minutes or 5 Hours" (*Kilobaud* No. 17, May 1978, p. 100), wherein the Shell sort was compared with the bubble and ripple sorts. Doyle pointed out that the simple sorts may not be efficient and suggested that Shell's sorting method could often be a better choice. It occurred to me that many readers could be interested in other fast sorting techniques. In particular, I felt that it might be useful to contrast the Shell sort with Quicksort.

Sorting is a common problem, and there are many known sorting techniques. There is not, however, a *best* sorting method. Every sort has its own strengths and weaknesses, and you should pick the technique that best fits your particular problem. A discussion of many sorting methods can be found in *The Art of Computer Programming, Vol. 3, Sorting and Searching,* by Donald E. Knuth, Addison-Wesley, 1973.

In this article, I present the Shell sort and two versions of Quicksort in BASIC. A few words are given on how each of them operates. Statistics for sorting arrays of 100 elements are presented for comparison of both sorting methods.

```
 95  REM SET SIZE OF ARRAY TO BE SORTED
100  LET M=N
105  REM SET SPACING BETWEEN MEMBERS OF A LIST
110  LET M=INT(M/2)
115  REM SEE IF DONE
120  IF M=0 GOTO 300
130  LET J=1
140  LET K=N-M
145  REM I AND L INDICATE THE ELEMENTS TO BE MERGED
150  LET I=J
160  LET L=I+M
165  REM PERFORM THE MERGE
170  IF A(I)<A(L) GOTO 240
180  LET T=A(I)
190  LET A(I)=A(L)
200  LET A(L)=T
210  LET I=I-M
220  IF I<1 GOTO 240
230  GOTO 160
235  REM MERGE NEXT TWO ELEMENTS
240  LET J=J+1
250  IF J<=K GOTO 150
255  REM BEGIN MERGE OF RESULTANT LISTS
260  GOTO 110
300  REM END OF SORT
>
```

Program A. Shell sort for N elements in array A.

The Shell Sort

The Shell sort (Program A) is a fast general-purpose sorting method. Operation of this sort is illustrated in Table 1. Given an array A of N elements, the sort first orders the pairs A(I) and A(I + (N/2)). This may be thought of as organizing the elements into N/2 ordered lists, each containing two members. The next stage is to merge pairs of these lists, forming N/4 ordered lists, each with four members. This ordered merging process is repeated until you are finally left with one ordered list of N elements, which is the desired result.

The Shell sort is much more efficient than the bubble sort. The theoretical running time for sorting N elements with the bubble sort is proportional to N^2 where, for the Shell sorting method, the worst case is proportional to $N^{3/2}$ and the average case is approximately proportional to $N^{5/4}$. The simple bubble sort will take 100 times longer to sort 1000 elements than it takes to sort 100 elements, while the Shell sort takes only approximately 18 times longer.

Quicksort

Another fast sorting method is Hoare's Quicksort (Program B). Quicksort works on the principle that it is easier to sort two small arrays than one large one. It picks one of the members of the large array for comparison and then divides the array into two parts—all elements greater than the comparison element and all elements less than the comparison element.

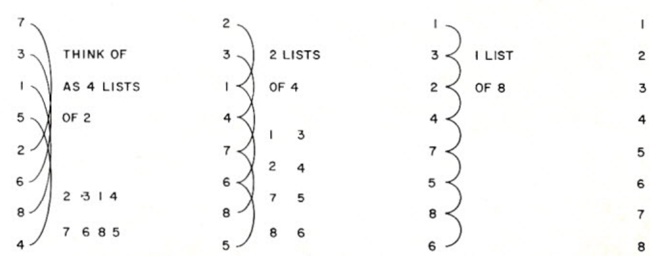

Table 1. Operation of Shell sort.

In ordering the elements from smallest to largest, all the smaller elements should precede the comparison element, and all those larger should follow it. With this organization, all that remains to be done is sort the subarray of smaller elements and the subarray of larger elements. This is done by reapplying the Quicksort method to each in turn.

The array is thereby repeatedly divided until only arrays of one or two elements are considered. A one-element array segment is certainly in order, and nothing more need be done. A two-element array segment may possibly require one exchange to be ordered. These steps are illustrated in Table 2.

A clever way to organize the array into subarrays of smaller and larger elements is to search from both ends for an element that is out of place (i.e., an element larger than the comparison element at the beginning of the array where smaller elements should be and, similarly, an element smaller than the comparison element at the end of the array where the larger elements should be). When two such out-of-place elements are found, they are exchanged. When the search from the beginning meets the search from the end, the comparison element is moved to this midpoint, and the array has been properly organized.

You must remember the boundaries of the array segment with the larger elements during the time when the array segment with the smaller elements is being sorted. This is done by storing the final position of the comparison element in an auxiliary array.

Quicksort likes disordered arrays. The average running time for sorting N disordered elements is proportional to N log(N), an improvement over even the Shell sort. Sorting 1000 disordered elements takes only about 15 times longer than sorting 100 elements.

The problem with Quicksort is that there are certain pathological cases for which it is slow (running time proportional to N^2). The difficulty arises when the comparison values all lie near the ends of their array segments. When this happens, instead of dividing the array in half, they divide it into a small segment and another large array segment. Since the sort is again dealing with a large array, the efficiency that comes from sorting two small arrays instead of a large one has been lost.

The usual version of Quicksort selects the first element of the array segment as the comparison element. This means that the pathological cases arise when the array is nearly ordered or nearly reverse-ordered. This is unfortunate because these are not uncommon cases.

The modified Quicksort presented here (Program B) attempts to ease the problem by selecting the element in the middle of the array segment for comparison. The modified Quicksort works best when the array is ordered or reversed. There is, however, still a pathological case where two nearly ordered lists are concatenated. This situation can arise when two lists are to be combined into one by appending one onto the other and then sorting.

7	4	2	1	1	1	1
3	3	1	2	2	2	2
1	1	3	3	3	3	3
5	2	4	4	4	4	4
2	5	5	5	5	5	5
6	6	6	6	6	6	6
8	8	8	8	8	7	7
4	7	7	7	7	8	8

Table 2. Operation of modified Quicksort.

If you wish to use the Quicksort method on arrays where such pathological cases may arise, it may be wise to introduce some disorder by selecting the comparison element at random. This can be done by modifying line 160 of Program B to read 160 LET M1 = INT (RND*(J − M)) + M. This modification introduces the overhead of calculating random numbers, as the cost of insuring against N^2 behavior.

In Table 3 some statistics are presented for sorting arrays of 100 elements by means of the Shell sort, the modified Quicksort and the randomized Quicksort

```
 95 REM INITIALIZE BEGIN AND END POINTS TO ENTIRE ARRAY
100 LET L=1
110 LET B(L)=N+1
120 LET M=1
125 REM SET END OF ARRAY SEGMENT
130 LET J=B(L)
135 REM SET START OF ARRAY SEGMENT
140 LET I=M-1
145 REM IF ONLY 1 OR 2 ELEMENTS THEN HANDLE SPECIALLY
150 IF J-M<3 GOTO 350
160 LET M1=INT((I+J)/2)
165 REM FIND A LARGE ELEMENT AMONG THE SMALL ONES
170 LET I=I+1
180 IF I=J GOTO 270
190 IF A(I)<=A(M1) GOTO 170
195 REM FIND A SMALL ELEMENT AMONG THE LARGE ONES
200 LET J=J-1
210 IF I=J GOTO 270
220 IF A(J)>=A(M1) GOTO 200
225 REM EXCHANGE OUT-OF-PLACE ELEMENTS
230 LET T=A(I)
240 LET A(I)=A(J)
250 LET A(J)=T
260 GOTO 170
265 REM ARRAY SEGMENT NOW DIVIDED, MOVE COMPARE ELEMENT BETWEEN
270 IF I>=M1 THEN  LET I=I-1
280 IF J=M1 GOTO 320
290 LET T=A(I)
300 LET A(I)=A(M1)
310 LET A(M1)=T
315 REM SAVE STARTING POINT FOR ARRAY SEGMENT OF LARGE ELEMENTS
320 LET L=L+1
330 LET B(L)=I
335 REM REPEAT QUICKSORT OF ARRAY SEGMENT OF SMALL ELEMENTS
340 GOTO 130
345 REM THE FOLLOWING HANDLES THE 1 AND 2 ELEMENT CASES
350 IF J-M<2 GOTO 400
360 IF A(M)<A(M+1) GOTO 400
370 LET T=A(M)
380 LET A(M)=A(M+1)
390 LET A(M+1)=T
395 REM SET BEGIN AND END POINTS FOR ARRAY SEGMENT OF LARGE ELEMENTS
400 LET M=B(L)+1
410 LET L=L-1
420 IF L>0 GOTO 130
430 REM END OF SORT
>
```

Program B. Modified Quicksort for N elements in array A. (Note: to obtain the randomized Quicksort, change line 160 to: 160 Let M1 = INT (RND(J − M)) + M.*

Sort	Array Compares	Array Exchanges	Additions Subtracts	Assignments	Other Compares	Division or RND	Aux. Array Needed
Ordered 1,2,3,4, . . . ,100							
Shell	503	0	1509	2523	510	7	0
Mod. Q	516	36	672	601	489	36	6
Rnd. Q.	795	49	1158	1012	861	49	5
Reversed 100,99,98,97, . . . ,1							
Shell	668	260	2099	3443	770	7	0
Mod. Q	516	85	671	600	488	36	6
Rnd. Q	782	96	1055	909	759	49	7
Shuffled 1,98,3,96, . . . ,99,0							
Shell	753	307	2316	3830	817	7	0
Mod. Q	547	47	813	720	595	47	6
Rnd. Q	649	83	988	833	697	52	7
Random 12,23,56,7, . . . ,43							
Shell	850	393	2596	4304	903	7	0
Mod Q.	560	91	928	817	705	51	6
Rnd Q.	716	158	931	788	658	48	8
Appended Ordered 1,2, . . . ,50,1,2, . . . ,50							
Shell	722	311	2268	3730	821	7	0
Mod. Q	1729	145	1060	937	767	62	21
Rnd. Q	721	152	1143	979	836	55	7

Table 3. Comparison of sorts of 100 elements.

sort. Comparisons and exchanges of array elements are counted separately from other operations since the time necessary for them depends on the type of table being sorted.

You should keep in mind that in all but the pathological case the number of operations necessary for sorting will increase faster with array size for the Shell sort than for Quicksort.

I hope the discussion of the sorting techniques presented here will aid you in selecting the best sort for your particular needs, and also that the explanation of two of the less obvious approaches to sorting may lead to the development of new sorting methods. ■

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Put Something Super in Your Life

And we mean an approximately $100 Elf—not a $35 million turkey.

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Since microcomputers have become so sophisticated, you may think that a one-board micro cannot offer enough to hold your interest. Think again!

The COSMAC Super Elf from Quest Electronics is an RCA CDP1802-based one-board microcomputer that sells for $106.95 postpaid, including power supply. The kit consists of a silk-screened, plated, glass-epoxy circuit board (with plated-through holes), 256 bytes of RAM, a 32-byte ROM monitor, two 7-segment LED displays, eight LED status and mode indicators, an audio amplifier and speaker, a video display chip, sockets for all ICs and a plug-in wall transformer. Also included are all other required components, an instruction and assembly manual, a print of the latest 3.0 version circuit board layout and the first issue of a special publication of 1802 software.

With the price of the large systems way out of reach—and some of the small ones still too high for a newcomer—Jim and I began to peruse the one-board computers to see what they offered and what we could expect. We are both amateurs in the computer field; Jim has had limited experience with a TRS-80, and I have learned from reading *Kilobaud* and *73* magazines. He is a high-school student and I am a Bell System cable splicer, so don't think our technical abilities exceed yours . . . they probably don't.

There are many different central processing unit (CPU) chips offered today with different word lengths and different types of construction (NMOS, CMOS, etc.). Almost every one of these chips has at least one hobbyist-sized microcomputer built around it. Some of them are worth considering because of the price, others because of software availability, while still others are S-100 bus compatible or have their own line of extensive hardware available. Jim and I had to remember that manufacturers are constantly upgrading their front-line CPUs and proposing new and improved versions, even new entire computers.

The Super Elf Package

It was difficult to pick one micro out of this menagerie, but some features and facts about the COSMAC Super Elf made this system stand out. Here is an offering, with a low initial cost, for a working, easy-to-use computer that is as expandable as your imagination and your pocketbook. The Super Elf is complete with its own power supply, eliminating the first potential snag in making a one-board micro operational.

Many options are readily available now, not later or in the planning stages, as is the case with some other micros. You can get a 4K memory board with cassette interface, room and positions on board for an optional 1K Super ROM, parallel and serial I/O options and an S-100 memory interface. A higher-level language—2K Tiny BASIC on cassette tape or ROM—is also available now. Quest Electronics carries an optional, attractive hardware case with a labeled front panel. The Super Elf is useful and functional in its bare-bones configuration, yet expandable without a large outlay of cash.

The COSMAC Super Elf uses the CDP1802 CD CPU by RCA powered by a 5 volt regulated supply. The Quest Electronics computer uses a separate clock generator running at 3.579 MHz divided by 2, even though the CPU has its own internal oscillator and can run at up to 3.2 MHz at 5 volts. The CDP1802D-version chip can run at up to 6.4 MHz using a 10 V supply. The Super Elf is only configured for the slower CDP1802CD at this time . . . apparently to keep the supply at 5 volts, making it TTL compatible as well as CMOS usable.

The 1802 is a register-intensive machine, with sixteen 16-bit general-purpose registers (one is used as the program counter), an 8-bit D register or accumulator, an 8-bit ALU and three 4-bit registers to select the 16-bit registers. It also has four flag inputs, one interrupt line for DMA operations, an output line for serial output or signaling, 15 I/O control lines and a 1-bit bidirectional bus.

The instruction set has 91 instructions to help use up to 65,536 possible bytes of directly addressable memory and interface with I/O devices. Standard arithmetic instructions are included, enabling you to construct typical math calculation subroutines.

The CDP1861CD Video Display Controller interfaces directly with the CDP1802 CPU. It is CMOS technology and a family device, eliminating much interfacing circuitry. If you program properly, it can display up to 128 vertical by 64 horizontal segments. The monitor picture is a bit map of memory, displaying the program-selected pages of memory (up to 1024 bytes) as a bright spot for 1 and a dark spot for 0.

Several sample display programs, giving various formats, are part of the 1861 spec sheets reprinted in the instruction manual. The display does not use the entire TV or monitor screen but, instead, projects on an approximately 3×3 inch area for a 12 inch monitor. This might limit the use of the video display to examining memory pages or drawing a small picture, unless, perhaps, you rewrite programs from the RCA COSMAC VIP manual, which is quite a job.

This chip does not display alphanumeric characters or any other special designs unless you develop the software to do so. The VIP has a larger monitor and CHIP 8, an interpretive language, which are used in the VIP video programs. This considerably complicates trying to use the VIP programs.

The video display controller on the Super Elf outputs through a circuit designed to allow direct connection to a video monitor or to an approved rf modulator. This feature can consid-

erably simplify interfacing either one you desire to use.

The Super Elf uses two 2101 RAMs, but other types, such as low-power 5101s, can be used. If desired, you can use RCA family devices, such as the CDP1824 32 × 8 bit or CDP1802 256 × 4 bit RAMs. Using these static RAMs will ease the interface requirements, but you might want to choose less expensive, more readily available RAMs.

The instruction and assembly manual provided is brief, to the point and adequate for its purpose. Since it does not provide Heathkit-type assembly instructions, you should know how to identify components and do quality, detailed soldering before you attempt the construction. We divided the component placement and soldering between us, as our abilities in that area varied widely. Happily though, we found no construction errors, so be encouraged when you begin assembly.

The manual contains five main sections and two appendices. Most of the pages describe the logic circuits and the assembly instructions. Copies of two manufacturers' spec sheets are included—one for the CDP1802 CPU and one for the CDP1861 Video Display Controller. These are helpful since the manual has no instructions for using the video generator other than for turning it on and off.

Other short sections in the manual explain the expansion buses, troubleshooting hints and external connections. A few, well-written pages review the operating features, controls and their usage. Overall, it contains enough info to enable you to assemble the computer, check it out and turn it on.

Even though this machine is intended for a beginner, we feel that some digital background is necessary to fully understand the manual. Unfortunately, it does not include one complete schematic or block diagram. Segments of the schematic are found near their explanations in the manual.

The first issue of an 1802 software publication, called

The COSMAC Super Elf and its accompanying literature.

Questdata, was included with the assembly and instruction manual. This interesting little pamphlet contains brief programs and explanations designed to guide the newcomer through the austere world of machine-language programming. It teaches how to operate an on-board LED for signaling purposes, how to produce a tone on the speaker provided and how to run a simple branch execution and a three-minute timer program.

Questdata is available from Quest for $12 for a one-year subscription. This newsletter is intended for people with any 1802-based machine, not just the Super Elf. Since the 1802 instruction set is the same regardless of the computer's hardware configuration, these programs are adaptable with only minor changes required.

Should the subsequent issues approach programming in the same manner as the first issue, they will prove useful to beginners, as the first issue has to Jim and me. This computer, as basically conceived, may attract mostly beginners, and we feel it is critical that this newsletter keep us interested in micros and in pursuit of better software and its applications.

After all, the 1802 is not a front-runner in the CPU race, so the 1802 computers should continue to provide a field for hobbyist pioneers for some time. It appears that the only good source for general-usage software is going to come from people familiar with the 1802, most likely owners of 1802-based machines.

Construction

The entire computer and its literature are shipped in a corrugated cardboard box with similar parts individually bagged. The ICs are packed in conductive foam (where they should remain until installed), and the circuit board is sealed in plastic.

When the computer arrived, we unpacked it carefully and used the parts list in the manual to check the contents. Checking and identifying the components against the parts list, we found no discrepancies. We inspected the circuit board for completeness and accuracy and found everything intact and ready to assemble.

The Super Elf has sockets for all the chips as well as an extra one for use with four wire jumpers. These jumpers are needed to terminate the inputs to another chip if the high address option is not purchased. All the sockets and components are high-quality, first-line parts.

Our most tedious job was installing the keyswitches for the keyboard. Each digit or letter of the keypad must be individually installed. Each must be tack-soldered on one lead first and then aligned to its final position before the other lead is soldered. After you have positioned them to your liking, you can complete the soldering. These keyswitches, the LEDs and the socket used for the seven-segment displays must all be mounted 1/2 inch off the circuit board if you intend to buy the optional cabinet. This standoff distance will bring all the LEDs and keyswitches into their proper position on the cabinet front panel.

The last items to install are the ICs. We recommend that you first take one simple precaution: Plug in the transformer and test whether the power on the board is regulated at the proper voltage. A wrong regulator or a few solder splashes could change the voltage; it might be easier to detect problems at this point, rather than after having blown some ICs.

Once the chips are installed and the power is finally turned on, the fun begins with the initial checkout. Simple tests check out any options that were purchased as well as the main functions. The main computer operations test themselves by displaying the proper digits, the proper mode or status LED. If the checkout is OK, proceed to program; otherwise, head for the troubleshooting section in the instruction manual to determine the problem.

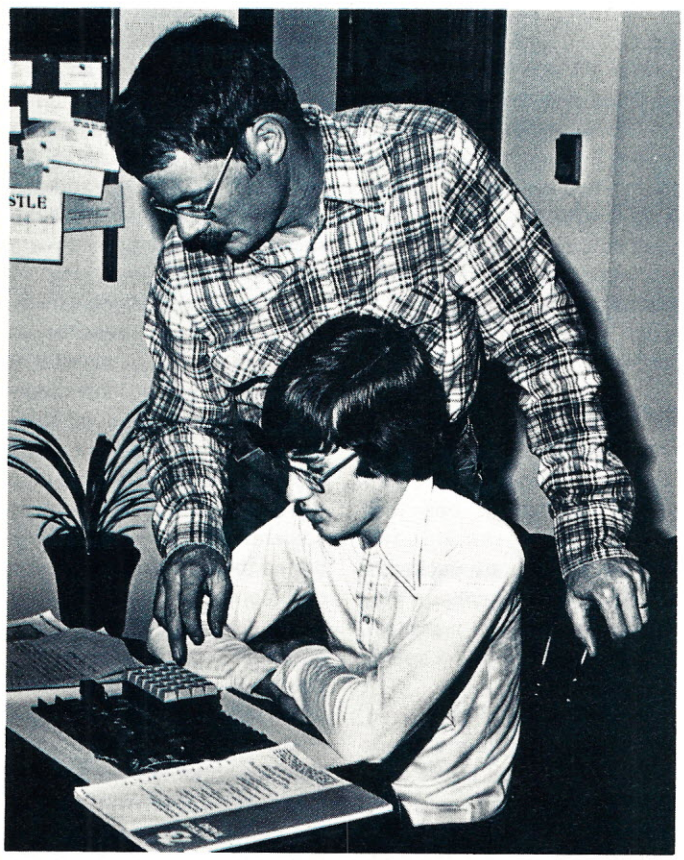
We did not graduate from the construction trouble-free, though I must admit we were close. One LED was defective (quickly replaced from the junk box), and the ROM monitor did not operate or list the proper instructions and data when single-stepped through. However, this did not curtail operations altogether, as the machine was used as configured without the monitor.

Jim wrote to Quest explaining that the monitor ROM was defective and received a reply within a week requesting the defective part. He shipped the defective ROM back to them and received a new, working one within ten days. The new ROM performed perfectly and added much pleasure to operating the machine.

The entire construction from the package opening to the start of the checkout took us about six hours. This time will differ according to your ability and patience.

Operation and Programming

Operating the Super Elf is a matter of entering a program with the 24 keys and using the two 7-segments to help with low and high address displays if these options are purchased.



The authors key in their tone program to see how it works.

The monitor on ROM can be used to help load and execute your programs, if desired.

When you use the monitor, there are distinct advantages. Using three different hex numbers, you can load a program at any location in memory, examine any location in memory or start execution of your program at any location in memory. This monitor only works with page 1 of memory, or, in other words, the 256 bytes furnished onboard. It can even be used to examine itself, since the monitor, when selected, uses the first 32 memory addresses (not locations in RAM).

If you write a program without the monitor and then later select the monitor when running the program, this might cause trouble unless you start writing your program at hex address 21. The monitor will steal the first 32 addresses when selected, so you must make room for it when you start to program.

Although literature and explanations are not supplied with the basic kit, the 1K Super ROM has much more muscle and flexibility. It can control the cassette loading and unloading as well as work on and control more pages of memory.

While using the computer, you will have four mode LEDs and four status LEDs to help interpret what the machine is doing. The mode LEDs tell whether the CPU is prepared to load, is reset, running or waiting. The state LEDs will indicate a fetch, execute, DMA or interrupt being executed by the CPU.

One LED is labeled Q and is a helpful programming tool. This Q line is a flip-flop, which is set or reset by op codes in the instruction set. It can also be tested with other instructions to initiate branches. A one-transistor amplifier drives a speaker off of this line and can be used to create clicking noises as it is pulsed or even audio tones by switching on and off.

After having read the supplied literature, you still may be in the dark as to certain features and operations. A good way to solve this problem is to have a copy of the RCA user manual for the CDP1802 COSMAC Microprocessor, MPM-201B, which sells for $5 from RCA. I think that Quest should supply this with the kit, even if it means a price increase to cover the cost.

This manual is not a spec manual as such but, instead, provides an understanding of the internal organization of the 1802 CPU and explains exactly what the machine instructions do. Diagrams for memory expansion and interfacing, I/O ports and typical small systems are just part of the information available. Simple programs and programming techniques cued to this chip were extremely useful to us as we had never done any programming in machine language.

When writing programs you must observe certain peculiarities in the Super Elf. Due to the way the computer hardware is configured, some operation codes are dedicated to board functions, such as display on and off, hex keyboard input and hex display output. Two of the flag inputs, EF1 and EF4, are also used for video display status and input switch status, respectively. This is a minor inconvenience, though, as two more flag lines and ten more input and output commands are available. The flag lines are branch testable, meaning the input switch can be used to initiate your program to test its state (depressed or not).

A simple program such as the one accompanying this article can create a tone from the computer's speaker. This program is an adaptation of one in the *Questdata* newsletter, but with some sophistication. It prevents having to key in the Q set and reset op codes as many times as in their program. In addition, your imagination can create many uses for this as a program subroutine, such as signaling the end or the midpoint in the program.

This program is not intended as a representation of perfect programming. It is simply a small example of one way to create a desired effect, and we

are sure many of you can do much better!

Interfacing and Expansion

After you have run several programs and have programmed up to address location FF (255), and maybe accidentally beyond, you will undoubtedly desire more memory. But perhaps this won't be satisfactory either, as you realize that the basic monitor only works with page 1 of memory. You notice that your fingers are tied in knots after loading 255 steps via the keypad and feel either a need for an ASCII keyboard input or a bionic hand.

All of these problems and others can be solved by options now available from Quest Electronics. A simple $4.95 memory backup kit supplies all the parts necessary to save your program when power is turned off. This option includes two AA nicad batteries that can save the 256 on-board bytes only for 20 hours or up to four weeks for 5101L RAMs. This memory backup kit can be a lifesaver when you develop a program or desire to save a good one, particularly if you don't have the expansion with its cassette interface.

If you are a little anxious and have a 44-pin edge card connector and a 44-pin experimenter's circuit board available, you can have some fun without using the Quest expansion board. The Super Elf has a spot in the upper left portion of the board for both their 50-pin interface and a standard 44-pin wirewrap socket, such as the Radio Shack 276-1553 ($2.99) that we used.

Not contained on the expansion bus is a regulated voltage. The connector instead has two unregulated 10 volt buses, one of which is an extension of the main board's supply good for up to 300 mA, and the other comes off the low and high address option supply and is good for up to 200 mA. We recommend that any substantial current, as well as any different required voltages, be supplied from an external supply.

The 44-pin connector does give access to both of the unused flag inputs, EF2 and EF3, and ground. By employing these two inputs and ground, you can control programs, change programs and scan these inputs, using the appropriate branching software. We have written a code oscillator program using just these three connections and a side paddle key. This is a tone- and speed-selectable code practice oscillator, not just a beeping speaker.

In writing the code oscillator program, we found that you can make up for some hardware deficiencies with software. Not wanting to build a separate oscillator, we made the computer supply its own. Intelligent, well-planned programming can make this computer seem bigger than it is, performing useful functions with a minimum of hardware and expansion.

A 4K memory expansion kit, including an on-board cassette interface, can be purchased for $79.95. On this board are thirty-two 21L02 RAMs and spaces for all of the offered options. This amount of memory should keep you pounding into the night before you run out of room.

This memory expansion board connects to the Super Elf with two 50-pin connectors that you must supply. The two boards are mated back-to-back and will fit in the optional cabinet, unless you have S-100 boards plugged in. Minor modifications on the Super Elf are required for this board and some of the options. These are easily accomplished because they were preplanned by the designer.

One of the more critical requirements is a bigger, separate power supply. You must supply 8 volts unregulated at 3 Amps and purchase an on-board 5 volt-3 Amp regulator option or supply 8 volts unregulated at 2 Amps and 5 volts regulated at 1 1/2 Amps. Some on-board options will require other voltages that you must supply. The 1K Super Monitor, for instance, requires +12 volts and −5 volts, both regulated to ±5 percent.

Keypad functions on the main board will be modified if you purchase the 1K Super

MA	Op Code	Mnemonic	Operation
00	F8	LDI	Load tone
01	22		Delay value
02	A1	PLO R(1)	Into Register 1
03	7B	SEQ	Set Q flip flop
04	81	GLO R(1)	Get Register 1 value
05	A2	PLO R(2)	Put into Register 2
06	22	DEC R(2)	Decrement Register 2 by 1
07	82	GLO R(2)	Get Register 2 value
08	3A	BNZ	Branch to 06 if
09	06	(Address)	Value is not 0, otherwise
0A	7A	REQ	Reset Q flip flop
0B	81	GLO R(1)	Get Register 1 value
0C	A2	PLO R(2)	Put into Register 2
0D	22	DEC R(2)	Decrement Register 2 by 1
0E	82	GLO R(2)	Get Register 2 value
0F	3A	BNZ	Branch to 0D if
10	0D	(Address)	Value is not 0, otherwise
11	30	BR	Branch to 03
12	03	(Address)	

Register Assignments

R(0)—Program Counter (this is always the case unless you change it in your program)

R(1)—Tone set (Delay) Register, higher value makes lower tone

R(2)—Loop value Register

Program listing to create a tone from the Super Elf's speaker.

Monitor ROM ($19.95). Any changes required by this option are also taken care of in the accompanying instructions.

If you have a Teletype machine, an ASCII keyboard or an RS-232 machine, you should purchase an interface from Quest Electronics at nominal cost. These options can make the operation of your computer much easier and provide a hard copy to boot.

Some of you may have older S-100 memory boards lying around, perhaps because they are too slow for your current Z-80 high-speed monster or maybe because they are 4K boards not worthy of a slot in your computer . . . at least when compared to today's high-density boards. In either case, the Super Elf has an S-100 memory interface available for $4.50.

The expansion board can take two of these options, which consist of three capacitors and a 100-pin socket each. Most S-100 boards, which are or act as a block of memory, can be used. Certain constraints are mentioned, so it would be wise to purchase just one of these options to see if the S-100 board that you are considering will work properly.

It's possible that some local computer clubs or enthusiasts may have a line on some inexpensive S-100 boards to expand the memory. *Kilobaud* advertisers also offer good buys on S-100 memory boards.

Quest is having some minor problems with address conflicts with the Tiny BASIC on ROM option, so you might experience some delay in your order. They are working these out and deciding whether to use 2708 or 2716 EPROMs at this time. It is now possible to get the Tiny BASIC on cassette or listing. They will also ship it on EPROMs if you desire to work out the address problems yourself.

Problems and Shortcomings

Every rose has its thorns, so to be fair we must point out some of the problems and shortcomings we encountered. After all, a balanced view will allow you to choose and spend wisely.

The first problem we encountered was a defective LED at the state one position. This stymied us on the checkout until we figured that the computer worked, but one LED didn't. A replacement from the junk box supply quickly had the problem resolved.

The second problem was

also obvious, but the cause was not as easily confirmed. The ROM monitor did not work and therefore did not properly identify when we tried to single-step through it. In the single-step mode you can use a regular VOM for checking voltages on the board. We used a VOM to confirm that the ROM was selected and that it output the wrong data. When it was removed, the computer still functioned, but with some inconvenience. We then had to load all programs from address location 00. Any memory locations that are not in sequential order must be reached by single-stepping, a tedious waste of time and energy.

When we used our own tone subroutine, the speaker became intermittent and then quit. Like the defective LED, this was a minor problem, since we had a spare speaker. Other shortcomings, such as the monitor's limited abilities, the failure to supply the RCA user manual and the limitations of the video display chip, have already been discussed.

The Super Elf does not operate very fast, primarily because of the low supply voltage and slow clock speed. It doesn't appear that the Super Elf can be sped up to compete with larger, faster machines without extensive modifications. We don't recommend this computer to anyone who expects more operating speed.

It is unfortunate that extensive pieces of hardware are not available for the Super Elf from other suppliers. While the KIM has floppy disk controllers, mainframe cages and much more, the Super Elf, on the other hand, has directly applicable options available only from Quest. A possibly adaptable EPROM programmer—from another supplier—is made for the 1802 in general.

A detailed search of our *Kilobaud* issues revealed that the only software currently available is the 2K Tiny BASIC from Quest. In addition, we found no programs for sale and located only two *Kilobaud* articles that can be used on or modified for the Super Elf without a detailed machine-language rewriting.

Having followed the prices of one-board computers, you may have noticed that the KIM-1 has dropped to $179. This does put it in the range of the Super Elf and might draw away many potential customers. However, some people will want a one-board just to learn on and to experiment with developing applications-oriented software and hardware. The cost difference between these two particular computers could make the Super Elf worth buying. It did make a difference in our case and still would be the deciding factor.

Conclusion

The Super Elf has its own I/O device, a 24-key keypad, a power supply with expansion buses and 256 bytes of RAM to work with. Many applications can be satisfied by this computer and its additional options. Although some drawbacks exist, more software and hardware are bound to be produced as 1802 machines become more popular. At this time, the *Questdata* newsletter can teach you to program and inform you of other people's programs.

You may have been putting off buying a computer because of the high price tag. If so, we suggest you consider the Super Elf. It may satisfy your needs and still be within your price range. Join the microcomputer crowd; put something Super in your life! ■

References

1. Quest Electronics, PO Box 4430M, Santa Clara CA 95054. Source for the Super Elf at $106.95 postpaid, and options.
2. RCA, Solid State Division, Somerville NJ 08876. Source for the RCA user manual for the CDP1802 COSMAC Microprocessor, MPM-201B, $5.
3. Optimal Technology, Inc., Blue Wood 127, Earlysville VA 22936. Source for 2708/16 EPROM Programmer w/software, $59.95 or $49.95 kit, advertised for the 1802 and other microcomputers.

✔ Reader Service—see page 179

Starship Attack

Up a laser river by the old military stream.

Marc Schwartz
26 Trumbull St.
New Haven CT 06511

You're poised on the launchpad, prepared to protect the food stations against an enemy Starship with its deadly laser ray. Yes, your deflector shields can withstand one laser ray . . . but two and it's all over! Luckily your ship is loaded with phasor torpedoes. You know that if you run out of torpedoes, though, you must attempt to board and capture the Starship. But you know, too, that the closer you get to the ship and the closer you get to boarding it, the more ferocious become its laser-ray defenses. Suddenly a Starship approaches . . . .

The Game

Starship Attack is a game played with an Apple II. Your selecting the speed of the action permits you to play at a pace either slow enough to be comfortable for a six-year-old or rapid and tense enough to excite an experienced space pilot. The entire game, which utilizes both paddles and both paddle reset buttons, can be played by one or two players and is quickly loaded into 4K of memory.

The game begins with your ship on the launchpad and the Starship closing in above you. There are four food stations in the sky, and it is your job to protect them.

You can steer your ship by tilting your paddle one way or the other to move left or right and by tilting the other paddle up or down to move in those directions. Pushing the reset button on a paddle fires a torpedo in the direction that paddle is tilting. Only a direct hit on the central section of the Starship destroys it.

The X-shaped, black Starship fires its laser ray horizontally and vertically, destroying everything in its path (including the ground!). If your ship is hit by a laser ray more than once, you lose the game.

You can capture the Starship by touching it with your ship. However, the program is written so that the closer you get to the Starship, the more frequently it fires its laser ray.

If the Starship is "forced" off the air space in which the game is played, you win. However, if *you* stray off the airspace, your ship is lost. You also lose if a laser ray wipes out the food stations before you destroy or drive off the Starship.

The Program

Statements 10 to 45 print the title. Statement 50 determines how many torpedoes you receive (between four and seven). In statement 60 you select the speed of the game. (By making

Program listing

```
  5 K=-16384:ZZ=-16336:KX=-16368

 10 TEXT : CALL -936: VTAB 2: TAB
     11
 15 PRINT "* STAR SHIP ATTACK *"

 16 TAB 11: PRINT "-----------------
    ---": PRINT : PRINT : TAB 6

 17 REM  COPYRIGHT VIDEOGRAPHICS INC
      1978
 20 PRINT "YOUR SHIP IS ON THE LAUNC
    H PAD": PRINT : TAB 7
 25 PRINT "THE STAR SHIP IS APPROACH
    ING": PRINT : TAB 15
 30 PRINT "YOUR MISSION:": PRINT
      TAB 2
 35 PRINT "CAPTURE OR DESTROY THE BL
    ACK STAR SHIP": TAB 3
 40 PRINT "BEFORE IT DESTROYS THE FO
    OD STATIONS": TAB 14
 45 PRINT ".......OR YOU!": PRINT
      PRINT : TAB 7
 50 T= RND (4)+4
 55 PRINT "YOU HAVE ";T;" PHASOR TOR
    PEDOES": PRINT : POKE KX,0
 60 INPUT "SPEED?(FROM 1(SLOW) TO 30
    0(FAST))  ",S:Q=300-S
 65 PRINT : TAB 4
 70 PRINT "DO YOU WANT INSTRUCTIONS
    (Y/N)?"
 75 IF PEEK (K)=206 THEN 80: IF
    PEEK (K)=217 THEN 2100: GOTO
    75
 80 CALL -936:TP=0: GR
 85 COLOR=6: FOR N=0 TO 39: VLIN
    0,39 AT N: NEXT N
 90 COLOR=14:M=8: FOR L=4 TO 28
     STEP 8: PLOT L,M: NEXT L
 95 COLOR=13: HLIN 0,13 AT 39: HLIN
    18,39 AT 39: HLIN 0,14 AT 38
      HLIN 17,39 AT 38
100 X=15:Y=37:A=23:B=18:HIT=0
110 ZX=0:ZY=0:F=0
115 X=X+( PDL (0)-128)/75:Y=Y+(
     PDL (1)-128)/75
120 C=2* RND (2)-1:D=2* RND (2)
    -1:A=A+C:B=B+D
125 IF A<1 OR A>38 OR B<1 THEN
    700
130 IF B>38 THEN B=38
135 IF X<1 OR X>38 OR Y<1 THEN
    900
140 IF Y>37 THEN Y=37
145 COLOR=1: HLIN X,X+1 AT Y
150 COLOR=0: HLIN A-1,A+1 AT B:
     VLIN B-1,B+1 AT A
155 IF Y=B AND X=A OR Y=B AND
    X+1=A THEN 800
160 REM  TORPEDO
165 POKE -16296,0: POKE -16294,
    0
170 IF PEEK (-16286)<128 THEN 180

175 XY=Y:ZX=1:PZ= PDL (1): GOTO
    190
180 IF PEEK (-16287)<128 THEN 240

185 XY=X:ZY=1:PZ= PDL (0)
190 IF TP<T THEN 200
195 CALL -936: PRINT "NO TORPEDOES L
    EFT": GOTO 240
200 TP=TP+1:TT=2*(PZ/128)-1
205 FOR ST=XY+TT TO 39*(PZ/128)
     STEP TT: COLOR=1
210 IF ZX THEN IF X=A AND ST=B THEN
    1000: IF ZY THEN IF ST=A AND
    Y=B THEN 1000
215 IF ZX THEN PLOT X,ST: IF ZY THEN
    PLOT ST,Y
220 M= PEEK (ZZ)
230 COLOR=6: IF ZX THEN PLOT X,
    ST: IF ZY THEN PLOT ST,Y
235 NEXT ST
240 M=8: FOR L=4 TO 28 STEP 8
245 IF SCRN(L,M)#14 THEN 255
250 F=F+1
255 NEXT L: IF F=0 THEN 1500
260 FOR N=1 TO Q: NEXT N
265 COLOR=6: HLIN A-1,A+1 AT B:
     VLIN B-1,B+1 AT A: HLIN X,
    X+1 AT Y
270 REM  LASER RAY:LA=0
275 Z= RND ( ABS (X-A)+ ABS (Y-
    B))/3+3
280 IF Z#3 THEN 110: COLOR=15: HLIN
    0,39 AT B: VLIN 0,39 AT A
285 FOR N=1 TO 10:M= PEEK (ZZ)-
     PEEK (ZZ): NEXT N
290 IF SCRN(X,Y)=15 OR SCRN(X+1
    ,Y)=15 THEN LA=1
295 COLOR=6: HLIN 0,39 AT B: VLIN
    0,39 AT A
300 IF LA=1 THEN GOSUB 1100
305 GOTO 110
```

S a small number, you make Q a large one. In statement 260, a large Q makes for relatively long-lasting frames and thus a slower game.)

Statement 85 colors the background; line 90 colors the food stations; and line 95 colors the ground/launchpad.

At statement 100, X and Y give the starting coordinates of your ship; A and B give those of the Starship. TP is the number of torpedoes shot; HIT is the number of laser hits you have received. ZX and ZY will be explained later.

In statement 115, X and/or Y is incremented by −1, +1 or 0, depending on whether the respective paddle is leaning one way or the other or is centered. In line 120 the Starship is made to randomly move up, down or sideways. In lines 125 to 140 the boundaries of the "airspace" are determined. In line 145 your ship is put on the screen; in line 150 the Starship goes on the screen. In line 155 the program checks to see if the Starship was captured.

Statements 160 to 235 fire the torpedoes. The actual firing for either reset button is done in statements 210, 220, 225 and 230. ZX, ZY and PZ vary depending on whether one or the other reset button is pressed.

Lines 240 to 255 check to see that all food stations have not been destroyed. And line 260, as was noted, controls the speed of play.

Lines 270 to 300 control the laser ray. In line 275, Z gets smaller as your ship gets closer to the Starship, and thus the laser fires more frequently.

Essentially that's it. I suggest that most adults start off at a speed of about 25 and fairly quickly get up to 300. Most kids under eight years old will do best to start at a speed of one and have a friend take over one of the controls.

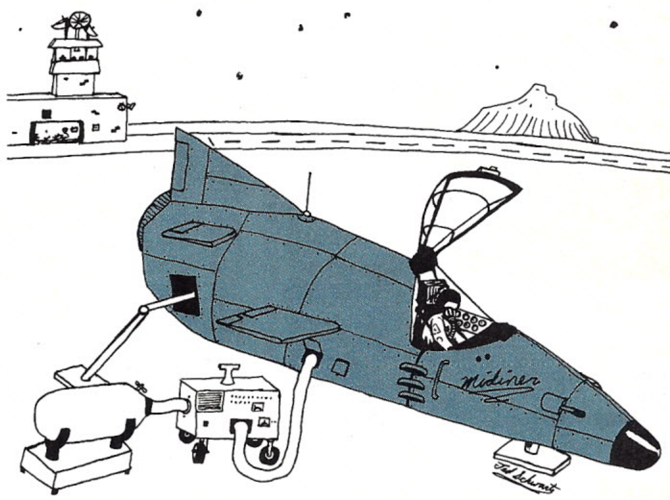
Watch out! Here comes the Starship! ■

```
700 CALL -936: PRINT "ENEMY DRIVEN O
    FF. GOOD WORK, CAPTAIN!": COLOR=
    13: HLIN X,X+1 AT Y-1: GOTO
    2000
800 CALL -936: PRINT "ENEMY CAPTURED
    . EXCELLENT!": GOTO 2000
900 CALL -936: PRINT "STRAYED INTO E
    NEMY AIRSPACE.": PRINT "SHIP LOS
    T."
910 COLOR=0: HLIN A-1,A+1 AT B:
     VLIN B-1,B+1 AT A: GOTO 2000

1000 CALL -936: PRINT "STAR SHIP HIT!
    ! CONGRATULATIONS!": GOTO 2000

1100 CALL -936: FOR N=1 TO 10:M=
     PEEK (ZZ): NEXT N
1105 IF LA=1 THEN HIT=HIT+1:LA=0
     : IF HIT=2 THEN 1115
1110 PRINT "DEFLECTOR SHIELD DAMAGED
    BY LASER RAY": RETURN
1115 CALL -936: PRINT "SHIP DESTROYED
     BY LASER RAY!": COLOR=0: HLIN
    A-1,A+1 AT B: VLIN B-1,B+1 AT
    A: GOTO 2000
1500 CALL -936: PRINT "ALL FOOD STATI
    ONS DESTROYED.": PRINT "COLONY N
    O LONGER VIABLE.": COLOR=0:
     HLIN A-1,A+1 AT B: VLIN B-
    1,B+1 AT A: GOTO 2000
2000 FOR N=1 TO 1500: NEXT N: GOTO
    10
2100 CALL -936
2105 PRINT "ONE PADDLE MOVES YOUR SHI
    P FROM SIDE TO SIDE. THE OTHER M
    OVES IT UP AND DOWN.": PRINT

2110 PRINT "PUSHING THE RESET BUTTON
    ON A PADDLE": PRINT "FIRES A PHA
    SOR TORPEDO IN THE": PRINT
    "DIRECTION THE PADDLE IS LEANING
     "
    .
2115 PRINT : PRINT "ONLY A DIRECT HIT
     ON THE CENTRAL CONTROLSECTION O
    F THE STAR SHIP DESTROYS IT."
     : PRINT
2120 PRINT "YOU MAY CAPTURE THE STAR
    SHIP BY GETTINGCLOSE ENOUGH TO T
    HE CONTROL SECTION TO": PRINT
    "BOARD IT.": PRINT
2122 PRINT "BEWARE OF THE WHITE LASER
     RAYS FROM THE STAR SHIP. IF YOU
     ARE HIT TWICE BY THEM,";
2123 PRINT "YOUR DEFLECTOR SHIELDS WI
    LL BE DESTROYED."
2124 PRINT "CAUTION: THE CLOSER YOU G
    ET TO THE STAR SHIP, THE MORE RA
    PIDLY IT FIRES!": PRINT
2125 TAB 8: PRINT "WHEN YOU ARE READY
     TO BEGIN,"
2127 POKE -16368,0
2130 TAB 8: PRINT "PRESS THE 'RETURN'
     KEY.": TAB 16: INPUT Z$
2140 GOTO 80
```



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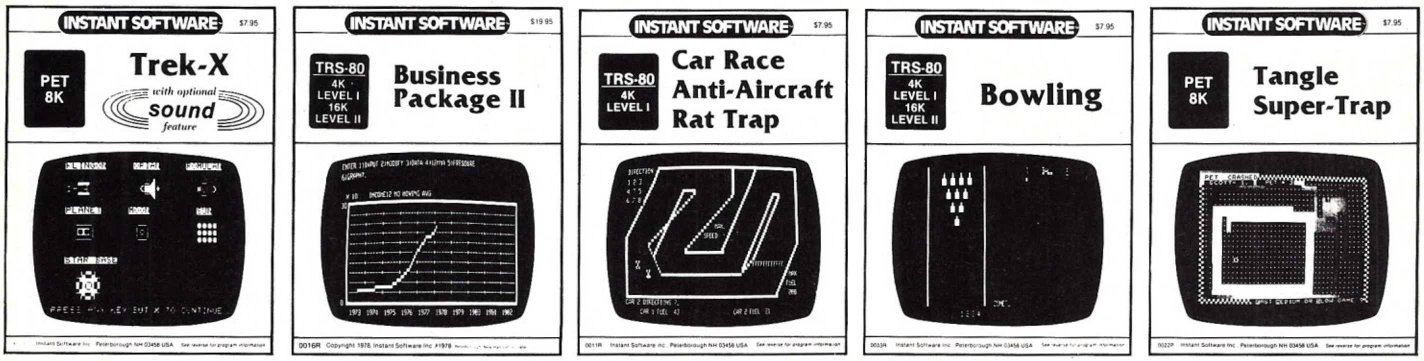

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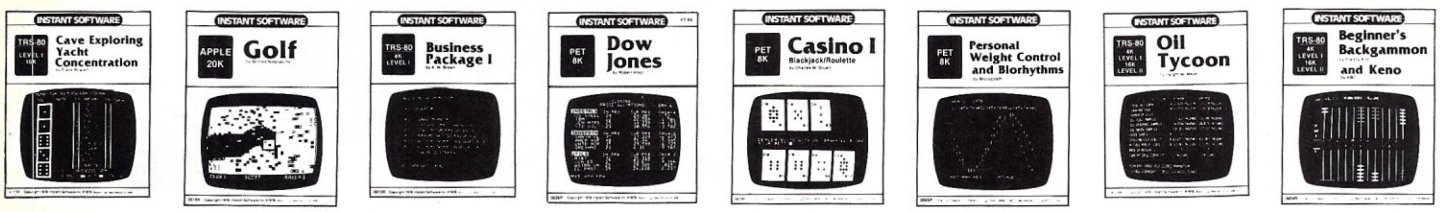

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Three games for the TRS-80. Cave Exploring is a game of trial, error, and exploration. Yacht is a two-player game based on the dice game of Yahtzee. Concentration is a computer version of the television game. $7.95 Order No. 0010R. Level I 16K

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This group of eight programs will be of frequent help to any technician, experimenter, or ham operator. Included are programs for Ohm's Law calculations, frequency vs. reactance, series resistances, parallel resistances, series capacitances, parallel capacitances, dipole antenna design, and yagi antenna design. $7.95. Order No. 0007R. Level I 4K and Level II 16K

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The Golf program as played on the Apple has some pretty tricky fairways lined with trees, sand traps, and water hazards. You have your choice of nine clubs to get your ball into the cup. But remember, the computer may give your ball an occasional slice, just to keep things interesting. $7.95. Order No. 0018A. 20K

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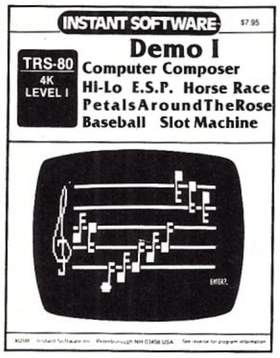

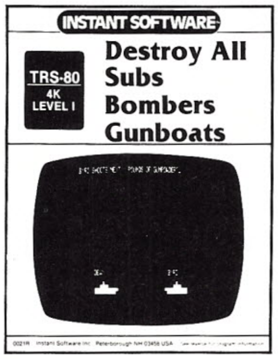

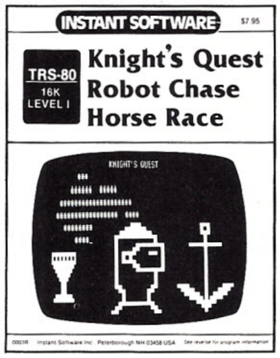

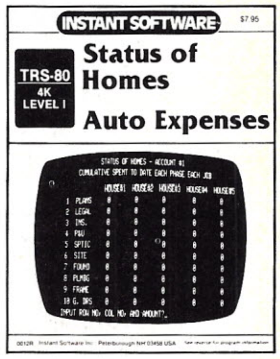

Demo I is perfect for those times when you want a few short programs to show your friends what your TRS-80 can do. Programs included are Computer Composer, Baseball, Horse Race, ESP, Hi-Lo/Tic-Tac-Toe, Petals Around the Rose, and Slot Machine. $7.95. Order No. 0020R. Level I 4K

Sharpen your skill at checkers. The PET will oppose you on the board, keep score, signal when you can jump, and time the moves with an on screen clock. The Baccarat program gives you the choice of two styles of play. It will deal the cards and keep track of your bankroll. $7.95. Order No. 0022P. Pet 8K

In Destroy All Subs, you must track and hunt down three submarines. Evaluate sonar reports and fire your depth charges to get a kill. But watch out! Don't damage your ship by hitting a mine or being torpedoed, or you're sunk. Get all three subs and you can expect a hero's welcome. 0021R. $7.95 Order No. Level I 4K

Battle sea or mountain demons as you travel around the kingdom of Norsax, in your quest to gain the treasure and become a knight. You're surrounded by homicidal robots, in Robot Chase, while trapped in an electrified prison. To save yourself, you must lure the robots onto the walls of your prison. $7.95. Order No. 0003R. Level 16K

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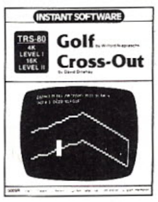

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Terminate Your Troubles

For less than $5, you can add your own active terminator to your computer.

Clive Bolton
79 Nassau Ave.
Manhasset NY 11030

When I set out to build my computer, I decided that only the best would do: a hefty 30 Amp power supply, an eighteen-slot motherboard—the works. I figured that I might as well include an active terminator also. After scouting around for a decent, simple design that used readily available parts, I came up empty-handed. Out of necessity, I designed my own.

Theory

Passive termination and active termination are a couple of terms that are frequently tossed around. The standard TTL termination is a 2.6 V reference, generally composed of 360 and 390 Ohm resistors in series across a 5 V supply with the TTL line connected at the junction of the two (Fig. 1). This approach is called passive termination; it allows for the proper sinking and sourcing of the TTL line by keeping the impedance of the line down, and thereby minimizing the pickup of noise. Each passive termination, however, draws about 6.7 mA from the power supply. Terminating all 94 of the S-100 bus lines this way requires a standby current of 600 mA.

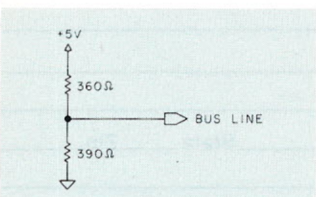

Fig. 1. Passive termination (1 of 94).

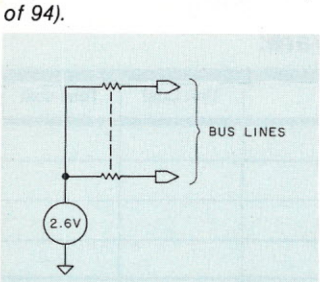

Fig. 2. Active termination.

These passive terminations not only are a burden on the power supply, they waste energy and create excess heat inside the computer, neither of which is desirable.

Active termination, on the other hand, uses an active regulating circuit and an isolating resistor to terminate the line (Fig. 2). Current can either source or sink through the isolating resistor, contributing to or drawing from the voltage source. Terminating more lines means adding additional resistors between the lines and the voltage source.

As the number of bus lines increases, there are more lines to be sourced and sinked, and the current requirement increases. Fortunately, at any given moment, there will be a fairly random mix of 0s and 1s on the bus. These feed to or draw from the same voltage source and tend to cancel out, reducing the average current requirements of the voltage source circuitry to a meager 30 or 40 mA.

Operation

My circuit uses a standard 7805 5 V regulator and a variable negative power supply as a ground reference. The 1k trimmer across the 4.7 V zener diode acts as a voltage divider to provide a −2.4 V reference for the regulator. Since the regulator provides a regulated 5 V above its ground terminal, the output is 2.6 V.

Construction

The construction of the regulating circuit is not critical. I built the regulator on a piece of perfboard and inserted the resistors, standing up, in the last empty slot on my motherboard. All the free leads are tied together and fed to the regulator. To minimize noise, the bypass capacitors are distributed across the network and soldered close to the resistors. Their free leads go to ground. Of course, the circuit could just as easily have been assembled on an S-100 prototyping board.

Calibration

There is only one adjustment to be made. After assembly is complete, check all wiring and remove all boards from the computer. Using a reasonably accurate voltmeter, adjust the 1k trimmer until the voltage coming out of the 7805 is 2.6 V above ground.

Performance

The design performs well. Looking at a few of the more active bus lines with an oscilloscope revealed that ringing had decreased substantially. Although I never before had experienced any problems that I could attribute to a noisy bus, I am very pleased with the results. I hope you will be too. ■

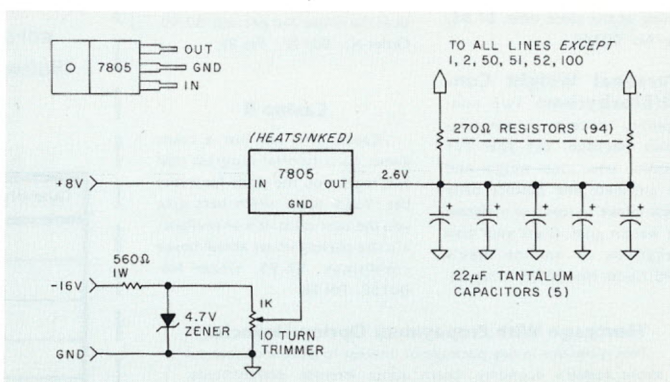

Fig. 3. Circuit.

✓ *Reader Service—see page 179*

Testing PET Search Algorithms

Benchmarking a search routine can reveal curious idiosyncracies in your interpreter. PET's real-time clock simplifies any timing comparison you're likely to encounter.

P. Kenneth Morse
3249 Ramsgate Road
Augusta GA 30909

In his article, "A Different Search Technique" (*Kilobaud*, May 1978, p. 112), Glen Charnock proposed a search algorithm that tested for the end of an array only after finding a match and challenged readers to benchmark the technique. As an avid hobbyist who enjoys the convenience of programming in BASIC but wished that BASIC would run faster, I determined to accept that challenge on my 8K PET.

My first step was to set up a benchmark test (see Fig. 1) that establishes an array of 100 numbers running consecutively from 501 (stored in Y (1)) to 600 (stored in Y (100)). Line 50 identifies 600 as the value sought; this ensures that the entire array will be searched. Line 60 takes advantage of the real-time clock built into the PET by storing the present value of the time counter TI as variable T. When a match is found, the value of (TI – T) gives the time required for the search in "jiffies" (note: a "jiffy" equals 1/60 of one second).

I then constructed routines for both search algorithms to search the Y array for the value 600 and to determine the time required for the search. Routine A in Fig. 2 provides a test of the traditional search procedure in which the loop index is incremented for each repetition of the search, and on each repetition a determination is made as to whether the array has been exhausted. Routine A required 88 jiffies. Even small changes can make a detectable difference: change A<=100 to A<101 in line 100 costs one jiffy!

```
10 DIM Y (101)
20 FOR A=1 TO 100
30 Y(A)=A+500
40 NEXT A
50 X=600
60 T=TI
```

Fig. 1. Benchmark array.

Charnock's suggested search procedure is shown in Routine B (Fig. 3), which differs from Routine A in that (a) the value sought is stored as the (K + 1)th element of the array, where K equals the original number of array elements, and (b) the end-of-array test is omitted until a match is found. This routine ran in 55 jiffies, a savings of 33/60 of one second.

```
70  A=1
80  IF Y(A)=X THEN PRINT "MATCH FOUND IN"; TI-T; "JIFFIES": STOP
90  A=A+1
100 IF A<=100 GOTO 80
110 PRINT "NO MATCH FOUND IN"; TI-T; "JIFFIES": STOP
```

Fig. 2. Search Routine A (88 jiffies).

```
70  Y(101)=X
80  A=1
90  IF Y(A)<>X then A=A+1: GOTO 90
100 IF A<>101 THEN PRINT "MATCH FOUND IN"; TI-T; "JIFFIES": STOP
110 PRINT "NO MATCH FOUND IN"; TI-T; "JIFFIES": STOP
```

Fig. 3. Search Routine B (55 jiffies).

```
70  FOR A=1 TO 100
80  IF X=Y(A) THEN PRINT "MATCH FOUND IN"; TI-T; "JIFFIES": STOP
90  NEXT
100 PRINT "NO MATCH FOUND IN"; TI-T; "JIFFIES": STOP
```

Fig. 4. Search Routine C (41 jiffies).

At this point, I observed that it would have been more convenient to use the FOR-NEXT construction rather than defining a loop index variable and specifically incrementing it each time through the loop. I assumed that there would be an overhead cost to using the FOR-NEXT construction and decided that I would like to find out what the cost might be.

I therefore replaced Routine B with Routine C (see Fig. 4), a simple FOR-NEXT loop that exits whenever a match is found. To my amazement and delight, I discovered that Routine C would run in 41 jiffies, or 53 percent less time than Routine A and 25 percent less time than Routine B. The simpler FOR-NEXT structure was actually outperforming the somewhat more cumbersome structures! Again, a minor change affected program execution time: specifying NEXT instead of NEXT A in line 90 saved two jiffies.

Apparently, you should never assume that the algorithm which is optimal in assembly language will also be optimal in BASIC. Users of BASIC should be aware that their built-in BASIC structures may be more efficient than other algorithms implemented in BASIC. ■

Reader Service—see page 179

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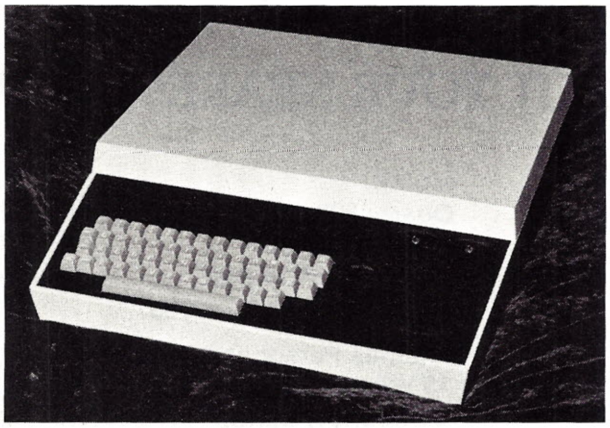

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Two Diamonds

If you've solved "Lucas' Puzzle" (November 1978, p. 98), try your hand at "Two Diamonds."

This is another one-player game that has been extremely popular for many years. Like the simpler puzzle called Lucas' Problem, Two Diamonds is played by reversing the positions of two sets of markers. Unlike Lucas' Problem, however, Two Diamonds features markers in a rather complex pattern. This pattern gives the puzzle its name.

The game is simple to play. Moves can be made in one of two ways. First, a simple move is to place a piece adjacent to a space into that space. Second, jump a marker over another marker (of either kind) and into the space. The two markers and the space must all be in a line.

The game is won when all the X markers have been moved to the left side of the board and all the * markers have been moved to the right side of the board. The game can be completed in about 40 to 45 moves, but a decent score in the mid-50s can be made. ■

```
10 INPUT "INSTRUCTIONS?",I$
20 IF I$(1,1)="Y" THEN GOSUB 500
30 LET X1=3 : LET Y1=5
40 DIM B(5,9)
50 FOR I=1 TO 5
60 B(I,0)=I
70 NEXT I
80 FOR I=1 TO 5
90 FOR J=1 TO 5
100 READ B(I,J)
110 NEXT J
120 NEXT I
130 GOSUB 270
140 INPUT "YOUR MOVE? ",X,Y
150 GOSUB 470
160 IF F=0 THEN GOTO 190
170 PRINT "ILLEGAL MOVE!"
180 GOTO 130
190 LET B(X1,Y1)=B(X,Y)
200 LET B(X,Y)=0
210 LET X1=X
220 LET Y1=Y
230 GOTO 670
240 M=M+1
250 GOTO 130
260 END
270 PRINT "     BOARD AFTER MOVE";M
280 PRINT ""
290 PRINT"  1 2 3 4 5 6 7 8 9"
300 PRINT ""
310 FOR I=1 TO 5
320 PRINT B(I,0);" ";
330 FOR J=1 TO 9
340 IF B(I,J)=99 THEN PRINT" . ";
350 IF B(I,J)=10 THEN PRINT " * ";
360 IF B(I,J)=0 THEN PRINT " 0 ";
370 IF B(I,J)=100 THEN PRINT " X ";
380 NEXT J
390 PRINT "" : PRINT ""
400 NEXT I
410 RETURN
412 REM ***THIS DATA SETS UP THE BOARD
414 REM ***99 MEANS UNUSABLE SPACE
416 REM ***10 MEANS A STAR (*)
418 REM ***100 MEANS AN X
419 REM ***0 MEANS THE EMPTY SPACE
420 DATA 99,99,10,99,99,99,100,99,99
430 DATA 99,10,99,10,99,100,99,100,99
440 DATA 10,99,10,99,0,99,100,99,100
450 DATA 99,10,99,10,99,100,99,100,99
460 DATA 99,99,10,99,99,99,100,99,99
470 LET F=0
480 IF B(X,Y)=99 THEN LET F=1
490 RETURN
500 PRINT"               TWO DIAMONDS"
510 PRINT ""
520 PRINT "THE OBJECT OF THIS GAME IS TO"
530 PRINT "MOVE ALL THE STARS (*) TO THE"
540 PRINT "RIGHT HAND DIAMOND AND ALL THE"
550 PRINT "X'S TO THE LEFT BY MOVING THEM"
560 PRINT "INTO THE SPACE MARKED WITH A '0' "
570 PRINT "TO MAKE A MOVE TYPE IN THE ROW"
580 PRINT "AND COLUMN NUMBERS OF THE MARKER"
590 PRINT "YOU WISH TO MOVE. A LEGAL MOVE"
600 PRINT "CAN BE MADE BY MOVING A MARKER"
610 PRINT "ADJACENT TO THE SPACE (0) OR"
620 PRINT "BY JUMPING A PIECE IN LINE WITH"
630 PRINT "A MARKER ADJACENT TO THE SPACE."
640 PRINT ""
650 INPUT "RETURN TO PLAY",I$
660 RETURN
670 LET F=0
680 FOR I=1 TO 5
690 FOR J=1 TO 4
700 IF B(I,J)=10 THEN EXIT 750
705 IF B(I,J)=0 THEN EXIT 750
710 NEXT J
720 NEXT I
730 PRINT "CONGRATULATIONS!"
740 PRINT"IT TOOK YOU ";M;"MOVES."
745 END
750 LET F=1
760 GOTO 240
```

Program listing.

How about a Printer?

A Singer Friden HSP-30 printer can be interfaced to an SWTP 6800—or other computer.

Jerry Sorrels
6266 Banner Ct.
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This article explains how to interface a Sanders 3110/ Singer Friden HSP-30, 30-character-per-second printer to an SWTP 6800 computer. The connection can be RS-232 serial, 7-bit ASCII parallel or both. This is not the usual printer-interface article with gobs of hardware modifications and then a software driver that isn't written for your CPU. Interfacing this printer requires a little hardware, which I like, and no additional software, which I like even better! Also, this printer should easily interface to most micros.

Printer Description

The Sanders 3110 prints 64 uppercase alphanumeric characters, which are arranged on the outer surface of a vertical print wheel that spins at 1800 revolutions per minute. This wheel is continuously inked by an ink roller. A character is printed when the print hammer forces the paper against the print wheel. The printer uses a sprocket paper feed that is adjustable from 3 to 14 7/8 inches.

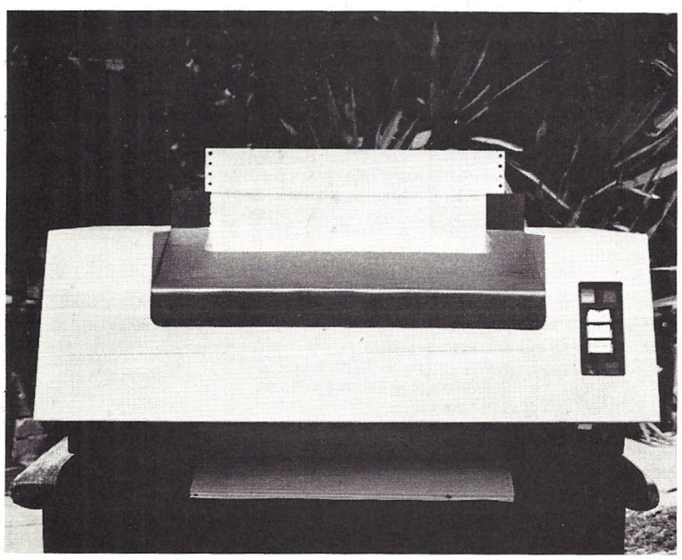
On the front panel are six switches that select: local, remote, form feed, line feed, space or test. There are also four indicating lights for remote, local, attention and power.

By using the switches, you can test most of the printer operations without connecting a keyboard or computer. This lets you get the printer working before starting any modification. The printer contains a power supply and serial-parallel logic board.

I bought my printer from Worldwide Electronics, Inc., 10 Flagstone Drive, Hudson NH 03051. It was sold without a cover but complete with ink roller, cord, manual and schematics, although not guaranteed to work. The cost was $271.51, including $33.01 freight to California. Worldwide Electronics will notify me when they get some covers in stock.

Extra ink rollers and some parts can be bought from TRW Customer Service, 1720 Beverly Blvd., Los Angeles CA 90026, which bought out Singer Friden.

When ordering, include printer model number and part number in manual.



The printer with the cover in place. Note the control switches on the right.

E27-E28
E29-E30
E34-E35
E36-E37
E15-E16
E18-E19
E21-E22
E24-E25
Form Feed (66 lines)
E2-E6-E8-E10-E12-E13-E14
E3-E4

Table 1. Jumpers to configure printer for serial and parallel input and form feed of 66 lines.

Easy to Interface

The printer electronics contain a parallel input with data strobe and printer busy line. To make this input compatible with the SWTP PR-40 software used in their BASIC, just connect it to a parallel I/O at port 7 and invert the strobe.

The printer also contains a serial-to-parallel circuit. In its original application the character transfer rate to the serial input was approximately 500 times faster than the actual

print speed. Also, the serial input was not RS-232. The serial modification consists of changing two timing capacitors and replacing the input circuit with a one transistor RS-232-to-TTL circuit.

Initial Setup

After unpacking the printer, connect the logic and decoder board to the printer with four wires and two connectors. Connect the blue and yellow wires at the front left of the printer to T5 and T6—either wire may go to T5 or T6.

Find the red and black wires at the back left of the cabinet and connect the black wire to T1 and the red one to T2 (T2 is below T1—on mine they punched a hole right where T2 was printed).

Next plug in the two connectors along the bottom, then slide the board into the slots on the left side of the printer.

There will be one or more cover interlock switches that will have to be defeated if you don't have the cover in place. The switches on mine had normally open and closed contacts, so I moved the wire from the normally open to the normally closed contact.

Load in some paper (tractor-feed type only), install the ink roller and plug in the ac cord. Before you turn it on be sure to read the operating instructions!

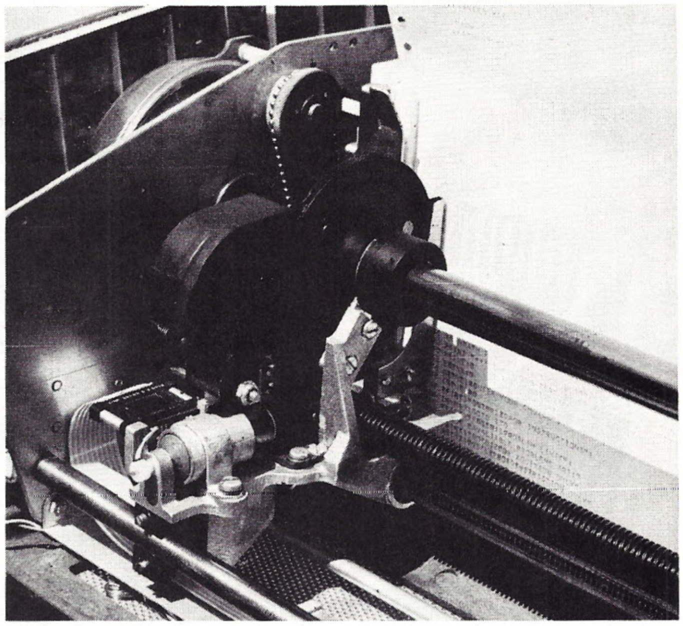
The first step is to get the printer working using the self-test mode. It is initiated from the front panel and prints all the printable characters twice, followed by a carriage return and line feed.

My printer needed a little cleaning, oiling and adjusting and was missing the 25k phase control. The printer came with a thick manual that covered most of the adjustments and lubrication. Using the manual's detailed section on operation, along with the five sheets of schematics, I did not have too much trouble getting the self test to work. It basically worked the first time!

Parallel Modification

The first and easiest input to get working is the parallel. The data strobe output by BASIC is a negative pulse. By removing an inverter on the printer's control, data and decode board, the printer's strobe will also be changed to negative. On the logic board, the trace that connects U18, pin 3 to the input connector J3, pin 19 is cut near U18, and the trace (J3, pin 19) is connected to U18, pin 4. Remove R13 and R14 and don't forget to show changes on your diagram 7100426L001 sheet 2.

The board contains several jumpers that select the serial or parallel input; by jumpering for serial either input may be used. I jumpered my printer as indicated in Table 1. Drawing 7100426L001 sheet 3 lists all of the jumper combinations, including the form feed selection (see the example on sheet 2).



This is the print wheel carriage assembly. It moves when the solenoid engages the lead screw. The ink roller housing is mounted next to the print wheel.

Interconnecting Cable

I converted the printer for both serial and parallel input so I could print any program or data that is sent to the terminal, without software modification. Also, I can run any program written for the PR-40. Remember: the missing link in the hobbyist field is compatibility.

To connect the printer to the computer, I used a flat cable made up of nine twisted pairs for the parallel and three conductors (two twisted) for the serial.

The printer end has a cannon DC 37S connector that mates with J3 of the printer. The parallel and serial sections of the cable each have a suitable connector that plugs into the back of my computer.

Note that on J3 each signal lead has its own ground (see Table 2). One twisted pair is used for each signal and ground combination. At the computer end, all the parallel grounds connect to the MP-LA parallel interface ground and the signal leads to their respective terminals. On the serial connector, the ground J3, pin 9 goes to the serial board's ground. J3, pin 10 connects to R0, and J3, pin 14, serial busy, connects to CI.

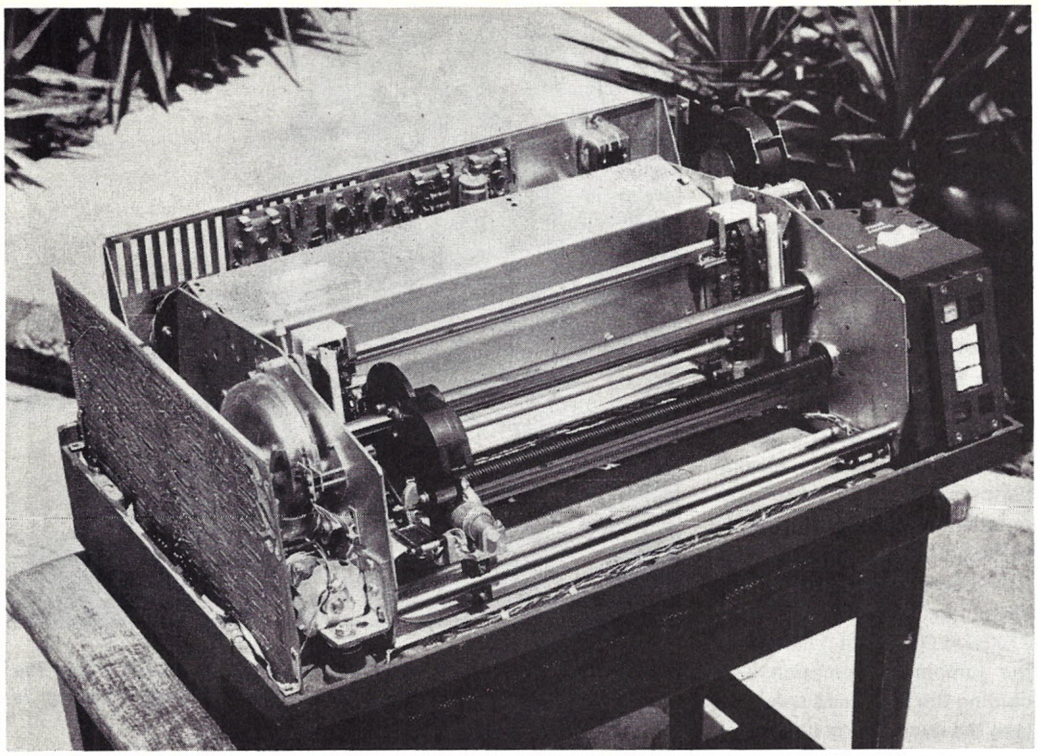
Grounding Change

To avoid a ground loop that could cause misprinting, the printer electronics should be grounded to the computer instead of its own ac cord ground. On the power supply board, located at the back of the printer, at the bottom right corner, remove the wire on terminal E9 and tape. This will isolate the printer electronics ground from the chassis ground. The printer electronics will now be grounded through the serial or parallel connection to the computer. The motor is insulated from the chassis by rubber mountings but is grounded through the printer's ac cord.

With the printer connected to a parallel interface, which is plugged into I/O port 7, and the

Printer Input J3			MP-LA Parallel Board	
Signal	GND			
2	21	BUSLY	C1	Data Ready
19	37	STRHIN	C2	Printer Ready
15	33	DATH 1	00	
16	34	DATH 2	01	
17	35	DATH 3	02	
18	36	DATH 4	03	
8	27	DATH 5	04	
11	30	DATH 6	05	
13	31	DATH 7	06	
		All Grounds connect to →	GND	
			MP-C	Serial Board
10	9	DATHSI	RO	RS-232 output
	→		GND	
14		Serial Busy	CI	Clock in

Table 2. Serial and parallel connections to the computer.



The complete printer without cover. On the left side are the logic and decode board, timing wheel and carriage return spring. The power supply and solenoid driver board are mounted along the back.

printer in the remote mode, it can be tested using a print or list 7 BASIC command.

Serial Modification

Now for the serial input that will let you print anything you can now send to your terminal. On the logic board replace capacitors C4 and C5 each with a .47 uF capacitor. I used tantalums (see drawing 7100426L001 sheet 3). The next step is to replace U1 and C1 with the RS-232-to-TTL circuit shown in Fig. 1. I removed U1 and C1 and soldered the four new input parts in the pads used by U1. A little planning on the parts layout will minimize extra jumpers.

The first input circuit I built inverted the signal and did not work. This happened because

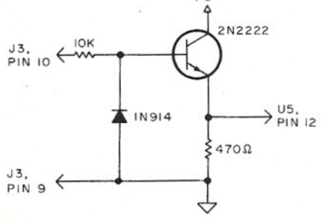


Fig. 1. RS-232-to-TTL input circuit to replace U1.

the information in the printer manual on page I-58, second paragraph, listed the data levels at the output of U1; these are, in fact, U1 input levels. Also, in Fig. 4-2, the top timing diagram should read input to U1, not output.

Connect the cathode of a small signal diode (IN914) to U3, pin 13 and the other end to the unused pin 14 of J3 input connector. J3, pin 14 will be cabled to the computer and connected to CI on the MP-C serial control interface. When the printer's serial-to-parallel circuit is busy, U3, pin 13 goes low; this forward-biases the diode and inhibits the baud clock input (CI) on the serial control board. This modification keeps the computer from sending characters (especially during a carriage return) until the printer is ready for them.

The serial input and ground of the printer is connected to the computer's serial control boards, RO and ground output terminals (RS-232). Also, don't forget J3, pin 14 to CI (see Table 2 for connections).

Serial Adjustments

The last step is to adjust the clock sync duration and clock duration one-shots—U5 for 30 characters per second. Refer to drawing 7100426L001 sheet 3 and to the manual, page I-58, for circuit description.

For these adjustments a triggered oscilloscope is very useful, but they can be made by trial and error. Connect only the printer's serial input to the computer; there is some interaction between the serial and parallel when they are both connected (more on this later).

First, we will use a scope. Temporarily disconnect the diode from J3, pin 14. Set the computer up to send a long string of data. I used MIKBUG's P command. Turn on the printer and leave it in the local mode. Connect the scope to U5, pin 9 and ground. While the data is being sent, you should see negative-going pulses (see manual, Fig. 4-12). Using R7, adjust the width of the negative pulse to 1.66 ms.

Now connect the scope to U4-6. This point is used because the pulses at U5, pin 7 are of short duration—80 ns—and can't be seen on my 10 MHz scope. Adjust R1 for 3.33 ms between the negative pulses.

If you are using the trial-and-error approach, also send a string of data to the printer with only the serial input connected. Turn on the printer, but place it in remote. Adjust R1 and R7 until the printer is printing what you are sending it. Set them to the center of the range in which you receive valid printing and disregard any missed characters at the beginning of each line. This is because we disconnected the busy line.

When the adjustments are completed, reconnect the diode to J3, pin 14.

When both serial and parallel inputs are connected to the computer, the parallel will always work when sent to, but the serial will only work if the computer reset is operated prior to sending data to the printer. This is because the PIA in the parallel interface is still sending the last character sent to it; it is latched in until another character is sent or the PIA is reset (parallel outputs all high). For this reason, I used separate connectors on the computer for the parallel and serial and only plugged in the one I used.

When using the parallel input with the printer in remote and the motor timed out, you can restart the motor from the computer by sending a hex 13 to the printer. In BASIC use PRINT #7, CHR $ (19).

In the serial input mode, the motor will start when data is sent to it; the data will be printed after a slight delay.

When using SWTP BASIC 2.0 with the serial input, four underscores will be printed before each print or list line. BASIC 2.0 uses $FF for padding characters, but the computer sends seven-bit ASCII and converts the $FF to $7F. The printer detects this as a lowercase character, converts it to uppercase ($5F) and prints an underscore. If this is too objectionable, change BASIC $047B-047E and $0326-0329 to 00.

I want to thank several persons who furnished ideas and inspiration for this project: Joe Eckardt, Mickey Ferguson and Bob Huish. ■

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A Look inside the TRS-80

We've looked at TRS-80 hardware. Here's an article from a software viewpoint.

Andy Latovich WB3JNZ
1500 Mohawk Street
Shamokin PA 17872

I ordered my TRS-80 in August 1977 and waited impatiently for it to arrive. It took four months! (The delay is only two or three weeks now.) The 4K BASIC was surprisingly capable, but I wanted to be able to program in machine language, too. That was a problem since there is no way to get out of Level I BASIC. Even so, I did have fun programming it.

The kitchen program tape arrived just about the time I got tired of BASIC. I noticed that the message center program on it was written in machine language. When loaded from tape, it executed automatically, without my having to type RUN. I knew then that it was possible to load a machine-language program from tape.

I took some TRS-80 tapes to my friend's house, and we looked at the signals on his scope. The scope showed very sharp pulses. The interesting thing was that the data was stored using a format similar to a floppy disk. If the data is a one, then an extra pulse appears between two clock pulses; for a zero, no extra pulse appears. My friend then designed a circuit to convert the pulses to TTL levels in order to read the tape with his homebrew 8080 system. He wrote a program to look for a one bit following the leader and, after finding that bit, shift each eight bits into separate bytes of memory.

I recorded a test tape on my TRS-80. It contained only a line number followed by one line of As. We read the tape into the 8080 system and dumped it in octal on his 5-level Teletype. Breaking a few bytes down into binary, we found that apparently the As were ASCII but they were shifted left. From the listing we saw that the first byte was 10100101, which seemed to be the sync byte since all tapes had it and the bits were symmetrical. By rewriting the tape read program to look for this byte, we were able to read the tapes correctly.

After a few days of studying the tape dumps, we figured out the tape format. Now we were ready for the big test—writing a machine-language monitor for the TRS-80.

My friend wrote the programs and recorded a tape on his computer as close as possible to the TRS-80 format. It sounded terrible but it worked! I finally had machine language on my TRS-80 (this was before T-BUG was available). I then wrote a slightly more complex monitor and went exploring the TRS-80. Earlier I had removed the ROMs from my TRS-80 and got them hooked up to the 8080 system in order to get a hex dump of them. I don't recommend removing the ROMs because it voids the warranty.

Well, anyway, by exploring with my monitor and manually disassembling (instant insanity, but I'm crazy anyway—I removed the ROMs, didn't I?) about 2K of the 4K BASIC, I discovered a few interesting things that might be useful to anyone using T-BUG to program in machine language on the TRS-80. I will also show how TRS-80 tapes can be read and written on other computers.

Tape Format

As I mentioned before, the tape format is like that of a floppy disk. The pulses are very short and steep, but a lot wider than the floppy's. There is an extra pulse between two clock pulses for a one bit.

A BASIC tape recorded on a TRS-80 consists of 128 bytes of zeros for a leader, the sync byte (10100101), a two-byte beginning load address, high-order byte first, a two-byte end-of-load address, high-order byte first, data bytes (eight bits, no parity bits, etc.) and a 2's complement checksum of all bytes following the sync byte. The checksum is obtained by adding all bytes after the sync byte, ignoring carries and overflows and taking the 2's complement of the result. The Z-80 has a 2's complement instruction; on other computers you can get the same result by inverting each bit and adding one to the byte.

Almost everything I have told you so far is in the T-BUG manual. I have explained it here for those people who do not own a TRS-80 or those who would like

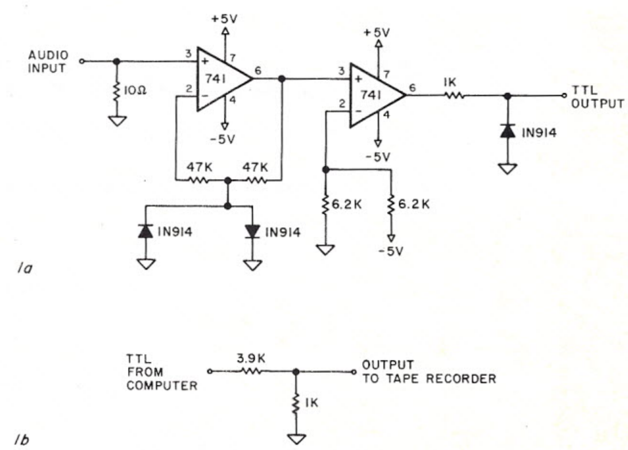

Fig. 1. The circuit in Fig. 1a is used to convert the audio data from the tape into TTL levels. Fig. 1b is an attenuator used to match the auxiliary input of most tape recorders. Some changes may be needed to match your particular unit.

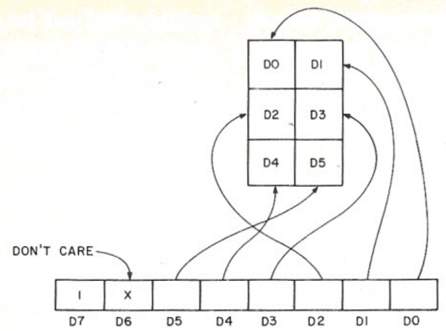

Fig. 2. This shows how the graphic blocks are controlled. Bit D7 must be on to enable the graphics. Bit D6 is not used.

their micro to be able to talk to one.

What is not mentioned in the T-BUG manual, however, is the way a machine-language program is handled. The beginning load address of a BASIC program is always 4200 hex. The end-of-load address is the address of the carriage return at the end of the last line of the BASIC program. Note that there is no execution address; control never leaves BASIC. In order to load a machine-language program and transfer control to it, Radio Shack uses an interesting trick in their object programs.

When CLOAD or CL. is typed as a command, it is decoded, and a jump is taken to that routine in the interpreter. The CLOAD routine then calls a routine to start the tape and read it. After the tape is loaded, it returns to the first routine and checks the checksum.

Memory in the TRS-80 starts at 4000 hex. The stack is initialized to 4200 hex before the jump is taken to the CLOAD routine. When that routine calls the read tape routine, the call instruction causes the return address to be pushed onto the stack at locations 41FE low-order byte and 41FF high-order byte. A machine-language program has a beginning load address of 41FE, so the first two data bytes from the tape are loaded into the stack area.

When the tape is finished loading and the read tape routine returns, the stack is popped into the program counter by the return instruction. Remember, a BASIC program begins loading at 4200, so it doesn't affect the stack. In the object program, though, the stack was loaded with the first two data bytes from the tape. This forms our "execution address." Note that the tape format has no real execution address; one was simulated by overlaying the stack area.

The Circuit

Now that we know the tape format, we need a circuit that will convert the audio from the tape into TTL levels. The circuit in Fig. 1a will do just that. All it takes is two op amps and a couple of resistors and diodes.

R1 matches the tape recorder output. The first op amp has a gain of one until the signal rises above a certain level. Then the diodes begin to clip the feedback voltage, and the gain of the op amp rises very quickly to its maximum level.

If the tape recorder volume control is adjusted so that only clock and data pulses rise above the threshold, the op amp will remove most of the noise. The second op amp with the 1k resistor and diode then converts the levels to TTL. This TTL signal can then control one bit of an input port. A program can then be written to read a TRS-80 tape.

I have not presented programs here because the program code will vary with the processor. However, on most processors they will generally work as follows.

Cassette Load. Wait for a clock pulse, then delay a little less than one millisecond. Check the input port a number of times to see if another pulse comes in—this section will probably be a subroutine. As each bit comes in, keep testing for the sync byte (A5 hex). When it is found, begin shifting each 8 bits (clock pulses not included) into separate bytes of memory. The rest should be easy: Get the beginning load address and the end-of-load address from the first four bytes just shifted in. Then load the rest of the data bytes into the proper memory locations. Check the checksum; if yours doesn't match the one on the tape, go to an appropriate error routine.

Cassette Save. There will probably be a subroutine here to output each bit to tape. The pulses should be fairly narrow —500 us is about right. It's not exactly the same as Radio Shack's, but it works. Output 128 zero bytes for a leader, then the sync byte, beginning load address, end-of-load address, data bytes and checksum. The circuit in Fig. 1b can be connected to one bit of an output port to attenuate the signals enough to feed into the AUXiliary input of most portable cassette recorders. Some experimenting may be necessary to get the proper level for your particular recorder.

Anyone who owns T-BUG will probably find the following information useful. The graphic blocks in the TRS-80 are actually character positions broken into three vertical blocks and two horizontal blocks. The graphics are enabled by the most significant bit, D7. When that bit is on, the six low-order bits then control the six graphic blocks as shown in Fig. 2. The video display RAM resides at 3C00 hex to 3FFF hex. 3C00 is the upper-left corner of the screen. This memory is 2102 static RAM, not dynamic like the rest of the TRS-80 memory.

A single input and output port is used to control the cassette and video display. Port 255 or FF hex is used. Each bit in the output port controls a different function. Bits 0 and 1 are used to write data on the tape. Bit 2 will turn the cassette motor on if it is a one, off if it is a zero. Bit 3 selects 32 characters per line on the video display if it is a one.

The input port uses only two bits—D7 for cassette data input and D6 to determine the state of the video display. D7 appears to be set at a one when a pulse from the tape comes in. It stays latched until the port is checked. Bit 6 is a one only when the video display is set to 32 characters per line.

Subroutines

If you are using the video display in your machine-language programs, then some of the Level I subroutines may be of use to you. The first and most useful is the routine to display a character on the screen and update the cursor. This routine can be called with a one byte Restart 16 instruction (this is a Z-80 mnemonic; RST 2 for the 8080).

The byte in the accumulator is then put on the screen at the present cursor position, and the cursor is updated. All of the registers are used with the exception of IX and IY. If the screen is full, it will scroll. ASCII characters are used; if bit 8 is on, then graphics will be displayed. An ASCII form feed is used to clear the screen. In hex this character is 0C.

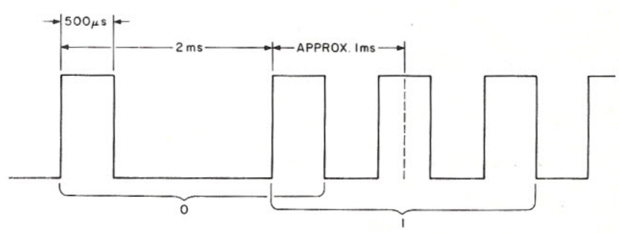

Fig. 3. This is the approximate timing of the tape data. Note how similar it is to a floppy disk. The output from the circuit in Fig. 1a will be inverted from that shown here (i.e., negative-going pulses). This is not the exact waveform used in the TRS-80, but it seems to work just as well.

A routine to print a string of characters is located at 094F. To use it, load DE with the starting address of the string and call the subroutine. Printing of the string will continue until a carriage return (0D) or a null character (00) is found in the string.

Another useful routine is the keyboard input routine at 0B40. A call to that location will check if a key is pressed. If no key is pressed, it will return with the zero flag set and the accumulator equal to zero. If a key is pressed, it will return with the ASCII character in the accumulator and the zero flag reset.

A good way to jump back if a key is not pressed is with the jump relative on zero instruction. The displacement should be a −5 (FB hex) if the instruction immediately follows the call. An example is shown below:

```
CALL KEYBOARD INPUT
JRZ        -5
```

The cassette routines can also be used. For example, to load a tape, execute a call to 0EF4. The tape will be loaded beginning at the address stored on the tape. Remember to allow one extra byte of memory for the checksum. If 256 bytes, for example, are dumped to the tape, 257 bytes will be needed when the tape is read back in. The cassette load routine uses all registers except IX and IY. When the tape is finished loading, the routine will return to the calling program.

While this routine can be useful, there may be times when you want to have the tape loaded in a different area of memory than that specified on the tape. Well, this is possible too! Here's how it can be done.

First, start the tape by calling 0FE9, then clear the accumulator and call the input bit routine at 0F81. This routine reads one bit from the tape and returns with the bit just read shifted into the least significant position (D7) of the accumulator.

Each succeeding call will cause the accumulator to be shifted left as the new bits come in on the right. Keep checking for the sync byte as each bit comes in. When it is found, call the input byte routine at 0FA1 to input the next byte. Since this is the first byte of the load address, call the input byte routine again. Save the load address and get the end-of-load address the same way.

Now that both addresses are in, calculate the number of bytes on the tape and add this to your own beginning load address to get the new end-of-load address. Load DE with your beginning load address and HL with the calculated end-of-load address. Push a register pair—it doesn't matter which pair, but something must be pushed onto the stack at this point. A jump instruction into the CLOAD routine at 0F18 will then finish the load. This routine must not be called because, prior to returning, DE is popped off of the stack. This is why we had to push something on the stack before jumping into this routine.

Since this is a routine that we are jumping into, it will have a return instruction. This means that a valid return address must be on the stack when the return instruction is executed. We can do this by making the push-register-pair and jump-to-0F18 instructions a subroutine and calling it. In other words, as long as a valid return instruction is on the stack before the register pair is pushed, everything will be OK.

The cassette save routine is usable also. Call 0FE9 to start the tape. Load HL with the beginning load address, DE with the end-of-load address and call the dump routine at 0F4B. Since the start tape routine uses HL, and probably DE, these registers cannot be loaded until after the start tape routine returns.

Address	Routine Name	Description/Comments
0010(rst 16)	Print Character	Character in accumulator is put on the screen in the present cursor position. The cursor is updated. If the screen is full it will scroll. ASCII characters are used. A form feed (0C) clears the screen, homes up cursor. Bit D7 if on enables graphics.
0B40	Keyboard Input	Returns zero if no key pressed. Accumulator contains character if key pressed.
094F	Print Character String	Prints string starting at address in DE. Continues until string contains null or carriage return.
0EF4	CLOAD	Loads a tape into memory. Load address is from tape.
0FE9	Start Tape	Turns on the cassette motor.
0F4B	Write Tape	Byte pointed to by HL is output to tape. HL is incremented. Continues until HL = DE. Start Tape must be called before HL and DE are loaded.
0F81	Input Bit	Reads one data bit from tape shifting the bit just read into the accumulator from the right.
0FA1	Input Byte	Reads one byte from tape and places it in the accumulator. Use this routine after the sync byte is found.
0F18	Input Data	Reads a byte from tape into address pointed to by DE. Continues until DE = HL. A return address and any register pair must be on the stack before jumping to this routine. It must not be called.

Table 1. Summary of useful routines in Level I BASIC.

Wrap-up

These are some of the routines I found in Level I. I have no idea whether some or all of them are used in Level II. The cassette routines will have to be different because of the faster baud rate in Level II.

I had a lot of fun "cracking" the Radio Shack tape format and exploring the TRS-80 with software. With T-BUG available, the TRS-80 should be even more desirable to the hobbyist. Although the tape format is not very fast, it is reliable. Any bad reads I have had could be traced back to the operator—me! With the information presented here, other computers will now be able to record programs for, and maybe even use, TRS-80 programs. Whether Radio Shack decides to come out with an acoustical coupler or not, they just might have a tape standard on their hands. ■

I had a lot of help from my friend Alex Burba in figuring out the tape format. It wasn't as easy as this article may lead you to believe. Actually, we had quite a few headaches doing it.

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At this time I wish to introduce myself. I am PERRY POLLOCK, the owner, manufacturer and designer of the products advertised in this issue of this fine magazine. In the issues to come, I will be introducing more powerful interfaces for the various popular computers.

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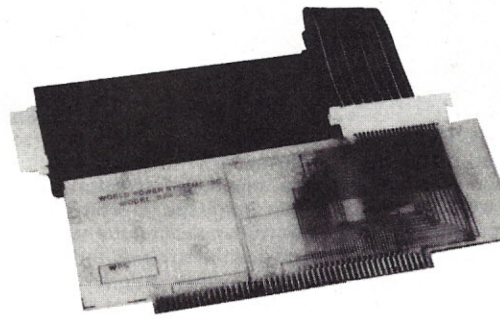

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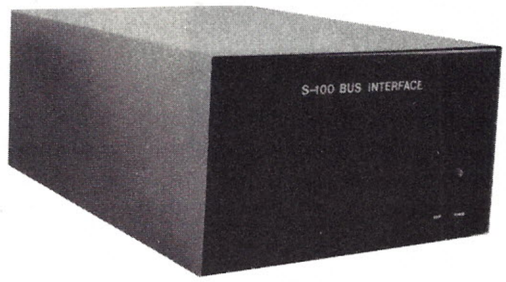

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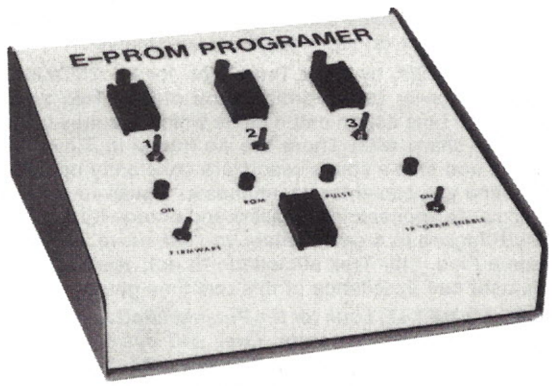

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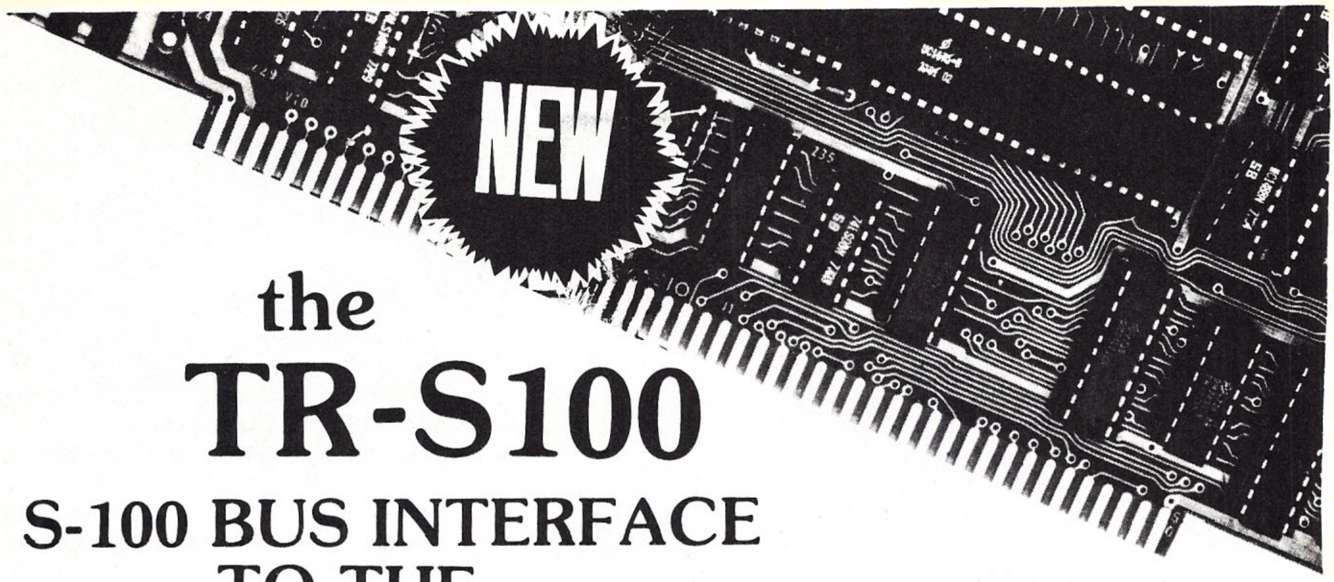

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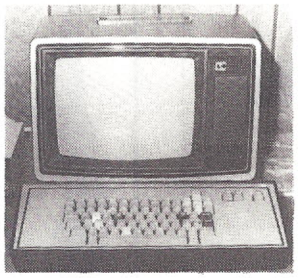

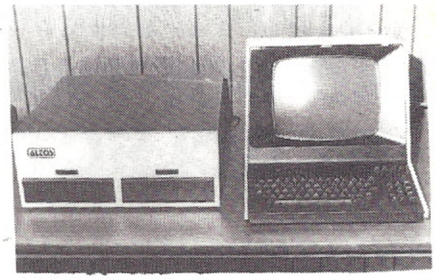

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32 K PET with full ASCII keyboard, but w/o cassette •1195
PET Printer-Impact printer with formatted printing, full graphics printing, TRACTOR feed... ..many features •975
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Prices quoted for new peripherals are preliminary and approx.

The COMPUCOLOR II, The Best Home/Personal Computer Available. Intelligent Systems Corporation of Norcross, Georgia has been building color video graphics terminals for years, and the Compucolor II is based on the same high level software and advanced hardware design of commercial/industrial systems costing thousands of dollars more. The Compucolor II comes with the following STANDARD features!

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-13" color CRT STANDARD-- 32x64 characters w/graphics
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-72 Key ASCII keyboard standard, with many extra features
-large selection of software on diskette, with more coming
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IT MAY BE HARD TO BELIEVE, BUT THE ABOVE SYSTEM WITH 16K USER RAM, 2 FREE DISKETTES (W/4,5 PROGRAMS EACH) IS ONLY •1695!

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Optional 117 Key keyboard (numeric cluster, etc.) •225
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Black Jack, Personal Finance 1, Personal Finance 2, Bonds & Securities, Equity.
Personal Data Base •29.95: Text Editor •24.95: Assembler •24.95: Programming manual •25: Maintenance Manual •50.

Write for further details!
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FOR RADIO SHACK TSR 80 Level II:

Tape #12 SPELLING—MATH: Spelling consists of two programs. You create word lists of your choice, and a 2nd program pronounces the words orally, queries, tests and grades your response. Math is a computer assisted learn-program of addition, subtraction, multiplication, and division, according to age and grade. $14.95

Tape #10 STARTREK, LEM, BATTLESHIP, DEFLECTION. $14.95

Tape #11 HANGMAN, BRICKS, BIORHYTHM, MASTERBAGLES. $14.95

Tape #13 FINANCIAL: A financial analysis and amortization program. $14.95

FOR COMMODORE PET 2001-8:

Tape #14 MUSIC: This program allows you to play from either the PET's keyboard or from a score edited into the computer.
MORSE-SENDER: This program allows you to enter a message and send morse code at the rate you specify.
MORSE-READER: This program allows the PET to read morse code you send by a key and displays the results on the screen.
MORSE-TUTOR: This program teaches morse code by either printing dots and dashes on the screen, or by making sounds. This program can also be used as a code practice oscillator.
With packaged speaker and amplifier hardware to plug into the PET $29.95

Tape #1 STARTREK, LEM, BATTLESHIP, DEFLECTION $14.95

Tape #2 SLOTS, BLACKJACK, POKER, CRAPS. $14.95

Tape #3 GOLF, BOWLING, HAMURABI, ROBOTS, CHECKERS. . $14.95

Tape #4 HORSERACE, BIORHYTHM, ROTATION, BRICKS, MASTERBAGLES. $14.95

Tape #5 CONCENTRATION, YAHTZE, HANGMAN, RICOCHET, CLOCK. $14.95

Tape #6 Computer assisted MATH INSTRUCTION. $14.95

Tape #7 FINANCIAL: A financial analysis and amortization program. $14.95

Tape #15 Depreciation-Present and future values- Capital investment 29 Financial rations-Discount rate of return-growth rate Curve fit Polynomial fit. $14.95

ADD $0.75 for postage & handling on all tapes.

ACCESSORIES:

PET IEEE 488 BUSS to RS 232 INTERFACE serial output (only) via 25 pin connector. Installs inside and uses the PET power. Simple installation.
KIT. $58.80
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Why settle for a HUG when you can have a Buss?

When I unpacked my Heathkit™ computer one of the first things I found was a membership form for the Heath Users' Group. I didn't join right away, but it seemed like a good idea, so I sent in my fourteen bucks. For a while there I felt like kicking myself because, frankly, I was a little disappointed. But it seems to be getting better now and Jim Blake has some fine plans for it.

Funny thing is that the only way I found out about them was by reading Buss. That's the newsletter on Heath Co. computers Charlie Floto puts out. When I first saw his ads I thought the guy was just another flake. But the "Heathkit™ Forum" he used to do for Wayne Green's magazine was pretty good so I figured, "Why not?" Turns out Charlie edits another newsletter on computers that goes for 87 bucks a year so I got off easy. The guy really knows what he's doing.

Anyway, the best thing about Buss as far as I'm concerned isn't the news Charlie digs up. It's those letters from other Heathkit™ users. I find out things they learned the hard way and even pick up a few hardware modifications.

Somehow Buss seems a little more personal than HUG. HUG gives me the official word from Benton Harbor, but the independent viewpoint of Buss is nice to have, too. Especially when I want to know what other companies are making for my system.

But don't take my word for it. Send in your Buss subscription and let Charlie know whether you'd rather start with the latest issue or available back issues (there were about eight last time I checked). Any time you're not satisfied with Buss, for any reason, a full refund is yours for the asking. Charlie doesn't take phone orders for subscriptions, but if you'd like to give him a call to chat you can sometimes catch him at 202/544-0484. Myself, I recommend just sending the guy your check and seeing what he comes up with. I never got a Buss I didn't like.

12 issues for $ 7.90 (U.S. funds only.)
18 issues for 11.50 (Outside North America,)
24 issues for 15.00 (12/$10; 18/$14.50;)
(24/$19 payable in US)

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Washington, DC 20003 ✓B43

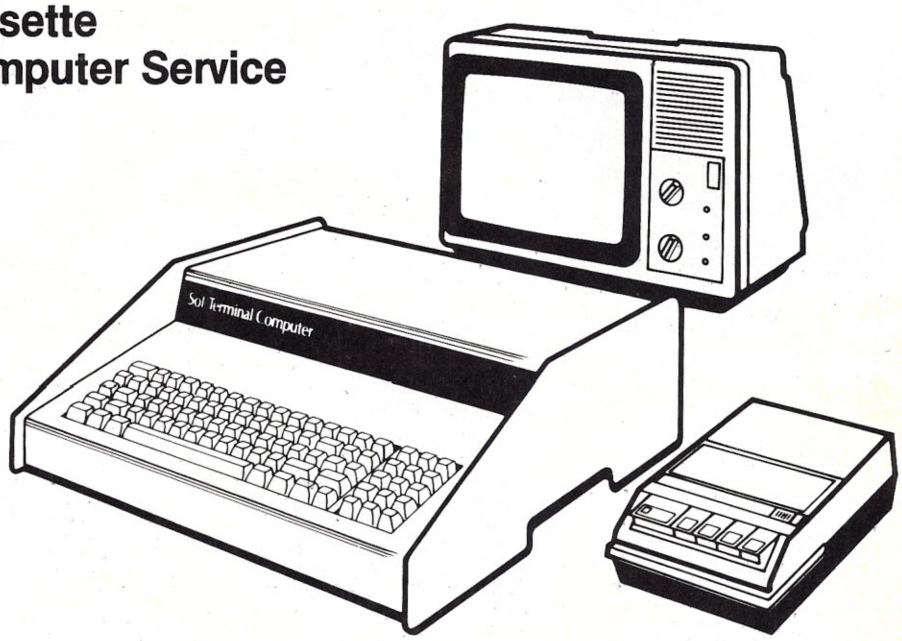
The Independent Newsletter of Heath Co. Computers

New Sol-20 Software

on Cassette
from E S V Computer Service

SALES/INVENTORY: This is a cassette sales package that will permit entry of business sales, sales person, item, and stock/inventory control number. The system will also flag any item that has reached a selected re-order point due to stock depletion. SALES/INVENTORY is designed to use two cassette tape units in a read-write operation. Report generation is based on the data on the cassette tape files. Cassette tape handling is done by software and by computer prompting to minimize data errors from improper operator actions. Uses Extended Cassette BASIC. Comes on CUTS cassette tape with documentation.
Order Number EC-011 . . . . $35.00

MONEY MANAGER: A collection of approximately 100 programs used to solve many financial problems encountered in the business world. From interest calculations, loan repayments, rates, depreciation schedules, and principal investment amounts, to trend lines and exponential curve fit. The MONEY MANAGER will handle many of the financial problems you are likely to be confronted with during any business day. The documentation also contains sample problems with answers to aid the user in becoming familiar with program operation. Uses Extended Cassette BASIC. Program comes on CUTS cassette tape with documentation.
Order Number EC-024 . . . . $40.00



Sol System II-A
from Processor Technology

CONVERSION: This comprehensive unit conversion program handles unit conversions for weight, volume, distance, speed, power, angular units, temperature and more. The operator keys in the quantity and units. The program then outputs the converted quantity in other measurement systems in a list. CONVERSION uses Extended Cassette BASIC and requires a Sol-20 with 32K or RAM. Program comes on CUT cassette tape with documentation.
Order Number EC-016 . . . . $19.50

BYTE-FINDER: This machine language utility will search or search/replace 1, 2, or 3 bytes in memory. The program has four versions, loading at 0000H, 4000H, 7000H and D000H. The operator selects starting and ending search addresses, number of bytes to be searched, data to be searched for, and optional bytes for replacement. An output is generated giving all memory addresses where the selected data were found. This is very handy for programmers who make many program patches or modify I/O routines, etc. Comes on 1200 baud CUTS cassette tape.
Order Number EC-022 . . . . $19.50

DISA-UTILITY: This support software is used to read the type files generated by the DIS-ASSEM-BLER. It will permit the user to format the file for compatibility with ALS-8 by determining the hex byte count required in each line. The file may then be edited with the ALS-8 EDIT command and saved on tape for later use or re-assembly. The utility treats the input file as a fixed length block so that large files may be treated without having memory overflows. This utility is not required when using the DIS-ASSEM-BLER with the Helios II disk system.
Order Number EC-023 . . . . $25.00

SINK: Three dimensional war game of your naval fleet versus the computer's fleet. Your fleet consists of destroyers in your home port and submarines hidden in the enemy port. The computer has destroyers in his port and submarines in your home port. The destroyers move and fire depth charges at the opposing hidden submarines. But watch out! The submarines can fire back with torpedoes. Size of the playing area can be changed to fit memory or alter the game complexity. SINK runs in Extended Cassette BASIC on your Sol-20. 32K RAM is required for size 5 ports. 48K is recommended for larger ports. SINK comes on 1200 baud CUTS cassette.
Order Number EC-017 . . . . $25.00

AMAZN: Find your way through the maze! Compete against an opponent and try for a new record time! This maze game contains a random maze generator which gives you a new maze every time. The cursor control keys are used to control movement through the maze. Written in machine language, AMAZN will run on a Sol-20 with 8K of RAM. Program comes on 1200 baud CUTS cassette.
Order Number EC-018 . . . . $19.50

MINE FIELD: A new machine coded game from that mad-man that developed SINK for your pleasure. Some people say he has some sort of death wish syndrome, but we find the rubber room he occupies during program development to be fairly safe. This game requires that you traverse an enemy mine field without getting blown to pieces or gunned down by enemy machine guns. Comes on standard 1200 baud CUTS cassette tape.
Order Number EC-025 . . . . $19.50

ORDERING INFORMATION: Order by name and number. All orders must be COD or prepaid. Add 3% for freight. Texas residents add 5% for sales tax. Cassette tapes are first generation tapes in standard 1200 baud CUTS format and are guaranteed for one year. Disks are Helios PTDOS compatible and are guaranteed for six months. Dealerships available.

COMPUTER PORT

926 N. COLLINS
ARLINGTON, TEXAS 76011 ✓C80
(817) 469-1502

✓ Reader Service—see page 179

✓ Reader Service—see page 179

Reader Service—see page 179

SMITHWARE for your PET

You have just unpacked your PET and are proudly showing it off to family and friends, when some obnoxious person asks the dreaded question, "BUT WHAT'S IT GOOD FOR?"

SMITHWARE from SBS is the answer. Not only do we have nifty games like LIFE, STARTREK, and BLOCKADE, but we also have SB9 PERSONAL ACCOUNTING SYSTEM. Here's what you get for only $16.00:

1) TAPETRANS--allows you to enter your checkbook register (or other financial transactions) onto cassette with comments. 500 account numbers.
2) TAPEDIT--allows correction of selected transactions of a file created by TAPETRANS. Outputs a corrected transaction file.
3) REGISTER--balances the transactions from TAPETRANS or TAPEDIT, displaying each transaction in detail with a running total.
4) RECONCILE--allows you to perform a check reconciliation on your bank statement. Outputs an outstanding check file for input to your next month's run of RECONCILE.
5) OUTSTANDING--reports your current outstanding checks and deposits from the outstanding check file.
6) SUMMARY--summarizes your financial transactions for you in general ledger format, by account number. Inputs summary file and monthly transaction files. Outputs a summary file. All input and output files are optional, giving outstanding flexibility. Very handy at tax time!

This is a professional quality accounting package which will form the heart of a complete personal financial system.

For the Commodore PET with 8K minimum.

ALSO AVAILABLE:

SB2	STARTREK--fascinating game of strategy & tactics	$8
SB4	UTILITY PACKAGE--reliable tape I/O, memory dumps, others	$8
SB5	BLOCKADE--highly graphic realtime spacewar game	$8
SB6	MONITOR--ten functions! 3,583 bytes free	$12
SB7	LIFE by Dr. Covitz--challenging game of cell colony growth & death . .	$10
SB8	FINANCE--Checkbook (no files), Stock Portfolio, Margin Accounts . . .	$10

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Computer Components of Orange County, Westminster, CA	(714) 898-8330
The Computer Store, Santa Monica, CA	(213) 451-0713
Jade Computer Products, Hawthorne, CA	(213) 679-3313
Opamp Technical Bookstore, Los Angeles, CA	(213) 464-4322
Personal Computer Corporation, Frazier, PA	(215) 647-8463

Or send $16.00, check or money order (Calif. residents add 6% sales tax) to:
SMITH BUSINESS SERVICES, P.O. Box 1125-K, Reseda, CA 91335 ✓S82

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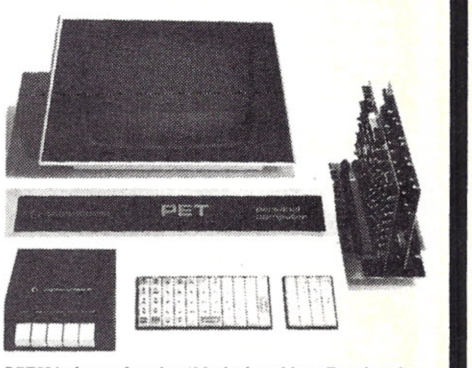
DEALER INQUIRIES INVITED

You can use the versatile new BETSI to plug the more than 150 S-100 bus expansion boards directly into your PET*!

On a single PC card, BETSI has both interface circuitry and a 4-slot S-100 motherboard. With BETSI, you can instantly use the better than 150 boards developed for the S-100 bus. For expanding your PET's memory and I/O, BETSI gives you the interface. The single board has both the complete interface circuitry required and a 4-slot S-100 motherboard, plus an 80-pin PET connector. BETSI connects to any S-100 type power supply and plugs directly into the memory expansion connector on the side of your PET's case. And that's it. You need no additional cables, interfaces or backplanes. You don't have to modify your PET in any way, and BETSI doesn't interfere with PET's IEEE or parallel ports. And—when you want to move your system—BETSI instantly detaches from your PET.

BETSI is compatible with virtually all of the S-100 boards on the market, including memory and I/O boards. BETSI has an on-board controller that allows the use of the high-density low-power "Expandoram" dynamic memory board from S.D. Sales. This means you can expand your PET to its full 32K limit on a single S-100 card! Plus, you won't reduce PET's speed when you use either dynamic or static RAM expansion with BETSI. Additionally, BETSI has four on-board sockets and decoding circuitry for up to 8K of 2716-type PROM expansion (to make use of future PET software available on PROM). BETSI jumpers will address the PROMs anywhere within your PET's ROM area, too.

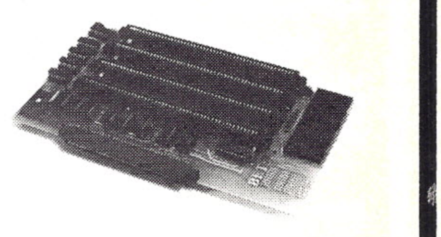


BETSI is the new Interface/Motherboard from Forethought Products—the makers of KIMSI™—which allows users of Commodore's PET Personal Computer to instantly work with the scores of memory and I/O boards developed for the S-100 (Imsai/Altair type) bus. BETSI is available from stock on a single 5½" x 10" printed circuit card.

The BETSI Interface/Motherboard Kit includes all components, a 100-pin connector, and complete assembly and operating instructions for $119.

The Assembled BETSI board has four 100-pin connectors, complete operating instructions and a full 6-month Warranty for just $165.

MAIL ORDERS ARE NORMALLY SHIPPED WITHIN 48 HOURS. VISA AND MASTER-CHARGE ORDERS ARE BOTH ACCEPTED.



BETSI is available off-the-shelf from your local dealer or (if they're out) directly from the manufacturer.

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Ask about our memory prices, too!

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*PET is a Commodore product.

✓ Reader Service—see page 179

Ever wonder what it takes to win a contest ?

In late 1978, Mullen Computer Products ran an applications contest for their Controller Board kit. Out of the many entries received, 7 of them stood out among an already good crowd. While we're congratulating the winners, you might want to see what we considered contest-winning material.

1st prize, a Mullen Controller Board and cash, went to John D. Gill of Blountville, Tennessee. Here are excerpts from his entry:

"I have been using one of your Controller Boards, for the past six months, as the main part of an interface between an IMSAI 8080 and a Friden Flexowriter. It solved the problem of how to connect the 5 Volt TTL logic of the computer with the 100 VDC logic used by the Friden relays . . . it surprised me that I did not have a noise problem when switching the (relays) . . . I took the precaution of not passing current through the Controller Board relays until they are fully closed, to avoid shortening the life of the contacts. This timing is done in software."

Included with the entry was a software listing and schematic. **Congratulations, John, on the winning entry.**

2nd prize winner, Peter Midnight of Oakland, California, now has a Mullen Extender Board kit and cash. He came up with another imaginative use for the Controller Board.

"(What) I have in mind is computerized editing and synchronization of double system sound tracks for my amateur films. Five of the output channels would give the computer control of one recorder. Two more channels would be connected to the speed control servo circuit of a recorder to keep it in sync with another tape of film. This would still leave an output channel free for generation of SMPTE code, the digital identification, and sync track on the tape. The input channels would be used with optical sensors in the projector and in the editing viewer . . . (using the hardware just described) the computer would then maintain a running display of relative and absolute frame counts and timing information."

We thought these two entries showed originality, practicality, and good usage of the Controller Board. But there were several other entries which, although they just missed the top honors, deserve an honorable mention.

Vaughn A. Jupe, N6VA from Carlotta, California, suggested using the Controller Board in conjunction with the AGC circuit of a ham receiver to keep a rotary beam aimed for maximum signal strength. A change in programming could allow satellite tracking or pre-aiming at any specific location on the globe.

Gregory Yob of Palo Alto, California, sent us a phase-controlled waterbed vibrator application, including details on the waterbed attachment and computer/solenoid interface.

Glenn King, from Topeka, Kansas, submitted several clever ideas. Our favorite was a telephone/computer interface that calls a directory on disk, searches for a name or one letter code, and even pulses to dial the number.

Paul S. McKnight from Washington, D.C., writes of using the Controller Board with a particular microprocessor-based typewriter that is operated by having the keyboard ground different combinations of lines through reed switches. Hooking the Controller Board relays in parallel with the keyboard relays provides the computer interface.

Mike O'Brien of Colorado Springs, Colorado, sent us a practical idea for an IC testing device based on the Controller Board.

As you can see, the quality of the entries was very high, and it was hard to decide on the winners . . . but we did manage to finally agree. **Thanks to everyone who participated in the contest, and our congratulations to the winners and runners-up.**

If you'd like more information on the versatile Mullen Controller Board, visit your local computer store or write us direct.

MULLEN Computer Products

BOX 6214, HAYWARD, CA 94545

M32

NOW A SOLUTION TO YOUR I/O HEADACHE #33

The OE 1000 Terminal is a low cost stand alone video terminal that operates quietly and maintenance free. It will allow you to display on a monitor or modified T.V. 16 lines of 64 characters. The characters can be any of the 96 ASCII alphanumerics, and any of the 32 special characters. In addition to upper-lower case capability it has a scroll up feature and full X-Y cursor control. All that is required from your microcomputer is 300 baud, RS 232 or 20 mA current loop, serial data. And if that is not enough the price is only $275.00 in kit or $350.00 assembled, plus $5.00 shipping and handling. To order phone or write:

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MC, BAC, COD accepted N.J. residents add 5% sales tax.
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ATTENTION TRS-80* OWNERS

At last! An attractive home for all of the parts of your system—keyboard, video display, power supply, and, last but not least, the cassette. The TRS-80* performs as a computer—Now it can look like one.

Classic black and silver color scheme to match your TRS-80*. Now your system can be portable without dismantling. The cassette recorder can easily be used along side the case and then conveniently stored in the side opening without disconnecting.

Send check or money order for $69.50 plus $5.00 for shipping to:

Michigan residents add 4% sales tax.) Visa and MC accepted with signature, exp. date, and number.

TRS-80 is a Product of Radio Shack

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-80– TRS-80—TRS-80—TRS-80—TRS-80—TRS-80—TRS-80—TRS-80—TRS-80 –TR

software from ACS service

1. ***Z-80 DISASSEMBLER:*** ***$20.00***
   Shows the symbolic code for the machine instructions stored in the memory of your TRS-80. Displays addresses and machine code in hexadecimal, ASCII representation, and symbolic instructions, with operands, on video monitor or line printer. Decodes all Z-80 instructions! Zilog mnemonics used. Code can be reassembled using the TRS-80 Editor/Assembler.
   REQUIRES:
   Level I or II. We have a version for all versions of the TRS-80 (please state which one you own). Z-80 monitor—same as above plus other monitor commands. Does source code dump on cassette tape $29.95.
2. ***DATA BASE MANAGEMENT:*** ***$99.95***
   This is a complete Data Base Management Program for the TRS-80 Disk System. It employs five commands: Find, Add, Change, Video and Print. You can name your own headings for all fields and can store any type of information for quick retrieval. All headings and data are kept on disk. Easy to use but professional. Example of use: Store index of magazine articles so you don't have to flip through all of your computer magazines to find an article.
   REQUIRES:
   Level II Disk Basic and one or more disk drives, 32 K RAM. Comes on cassette.
3. ***19 KEY HEXADECIMAL NUMERICAL KEY PAD*** ***$69.95***
   Ribbon Cable plugs into keyboard or expansion interface. No modifications necessary.
4. ***COMPREHENSIVE MEMORY TEST:*** ***$15.95***
   Test ROM, RAM, and video RAM displays number of part on error detection. Routine's for all Level II TRS-80s.
5. ***INVENTORY:*** ***$20.00***
   Uses sequential files on disk to store inventory. You can list stock number, item name, location, how many, cost per unit, number per case, cost per case, and next shipping date. Commands include: Check for item, change item info, add new items, and print entire inventory to line printer. Can be used without line printer. Easy to use, just load and run, type in your inventory and you are ready for quick retrieval of any item.
   REQUIRES:
   Level II disk drive and basic, 16K RAM.
6. ***TAPE DUPLICATION PROGRAM*** ***$99.95***
   REQUIRES:
   Level II, 16K RAM & Disk.
7. ***MAILING LIST:*** ***$89.95***
   Handles thousands of names.
8. ***EDITOR ASSEMBLER ON DISK INTERACTS WITH DISK.*** ***$29.95***

NOTE:

All programs came on cassette unless noted. If you want it on disk, please specify so and add $7.50 to your order, or send a diskette with your order. All orders shipped same day. All programs guaranteed to run.

MASTER CHARGE & VISA WELCOME

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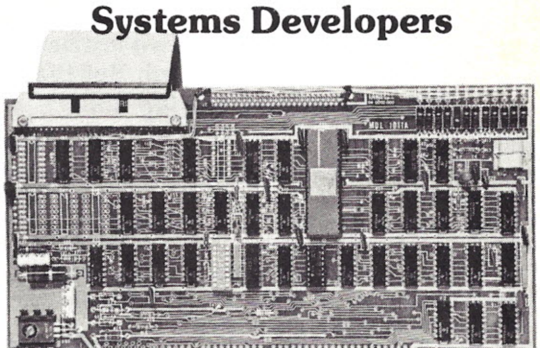

- Plugs directly into your IMSAI or ALTAIR* and handles up to 4 standard single drives in daisy-chain.
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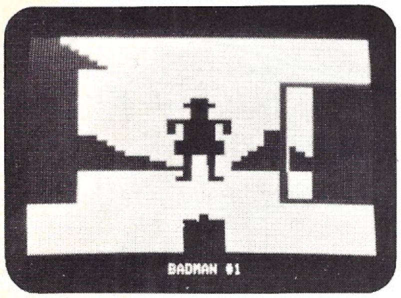

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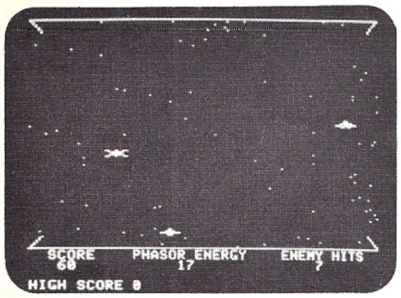

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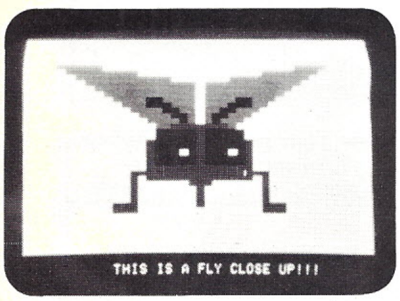

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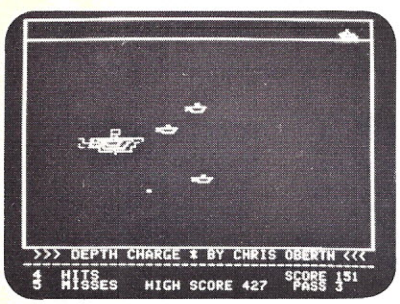

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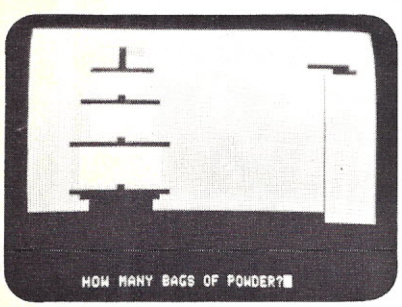

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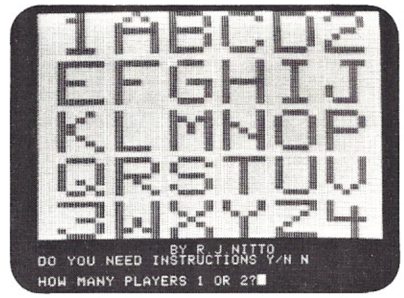

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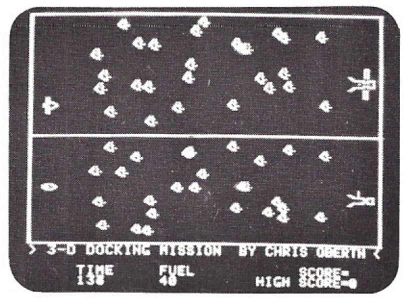

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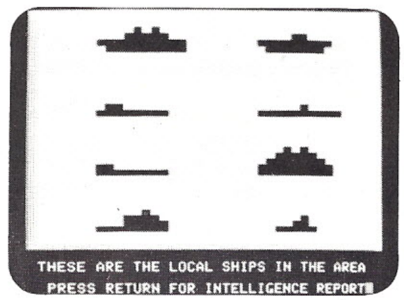

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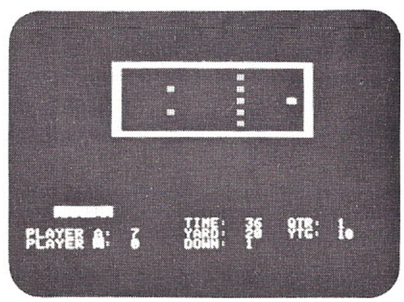

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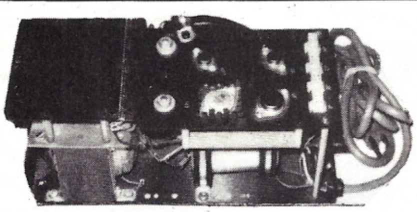

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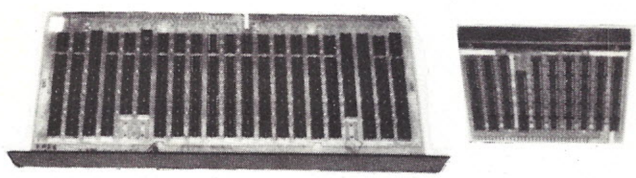

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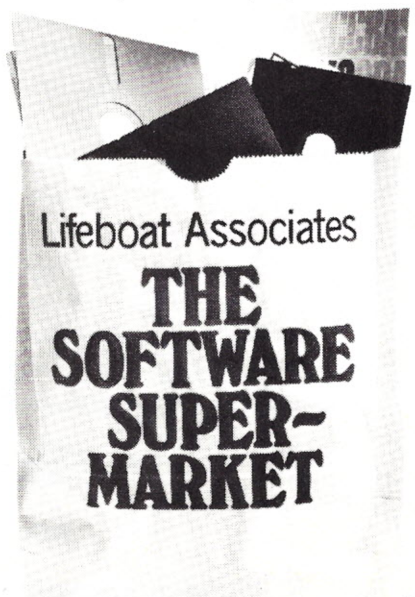

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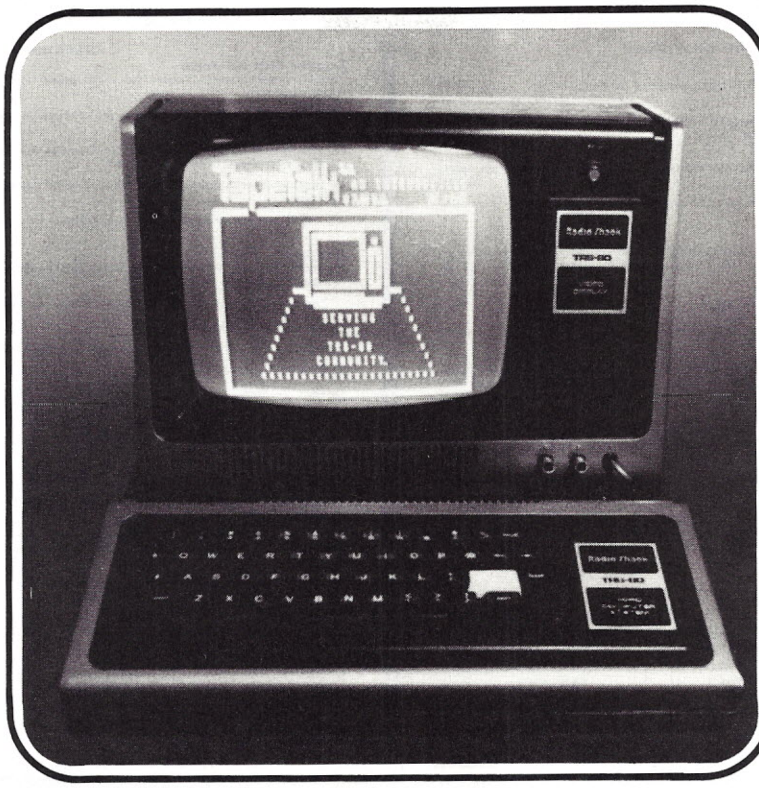

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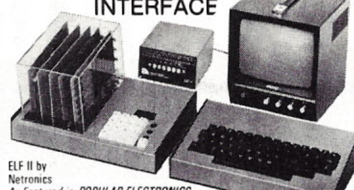

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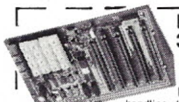

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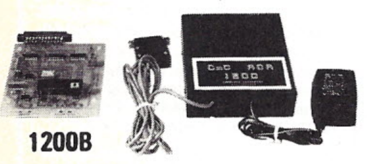

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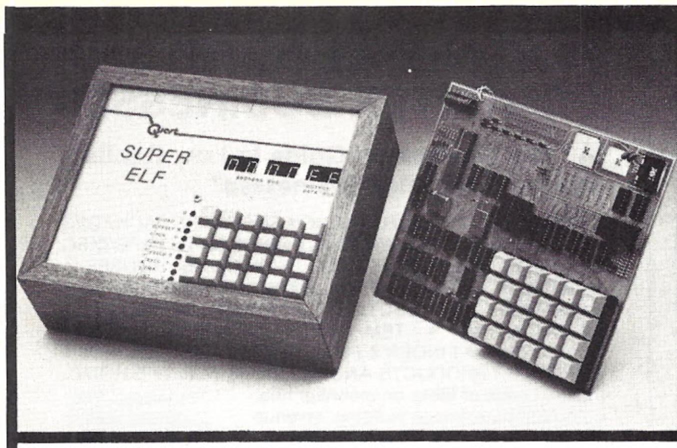

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The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are shown on several LED indicator lamps.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, input, memory protect, memory select, monitor select** and **single step**. Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector for PC cards and a 50 pin connector for the **Quest Super Expansion Board**. Power supply and sockets for **all** IC's are included in the price plus a detailed 90 page instruction manual.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Hardwood Cabinet** with drilled and labelled front panel **$24.95. NiCad Battery Backup Kit $4.95.** All kits and options also come completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year. New 100 page software manual Vol.1 $4.95.

Tiny Basic for ANY 1802 System

Cassette $10.00. On ROM Monitor $38.00. Super Elf owners, 30% off. **Object code listing or paper tape with manual $5.50.**
Original ELF Kit Board $14.95.

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed** ($12.00 value). EPROM can be used for the monitor and Tiny Basic or other purposes.

A IK Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability, and video graphics driver with blinking cursor. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. A Godbout 8K RAM board is available for $135.00. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $12.50 for easy connection between the **Super Elf** and the **Super Expansion Board.**

The **Power Supply** for the Super Expansion Board is a 5 amp supply with + 8v ± 18v + 12v − 5v. Regulated voltages are ±5v & +12v $29.95. −12 volt optional. Deluxe version includes the case at $39.95.

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7402N	.17
7404N	.19
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7410N	.17
7414N	.63
7420N	.17
7422N	1.39
7430N	.20
7442N	.50
7445N	.69
7447N	.60
7448N	.69
7450N	.17
7474N	.29
7475N	.49
7485N	.88
7489N	2.00
7490N	.43
7492N	.43
7493N	.43
7495N	.69
74100N	.90
74107N	.29
74121N	.34
74123N	.59
74125N	.39
74145N	.69
74150N	.95
74151N	.69
74154N	1.00
74157N	.69
74161N	.87
74162N	.87
74163N	.87
74174N	.96
74175N	.90
74190N	1.15
74192N	.87
74193N	.85
74221N	1.55
74298N	1.65
74365N	.66
74366N	.66
74367N	.66

74LS00 TTL	
74LS00N	.25
74LS02N	.25
74LS04N	.25
74LS05N	.25
74LS08N	.25
74LS10N	.25
74LS13N	.40
74LS14N	.90
74LS20N	.25
74LS22N	.25
74LS28N	.41
74LS30N	.25
74LS33N	.39
74LS38N	.30
74LS74N	.35
74LS75N	.47
74LS90N	.51
74LS93N	.51
74LS95N	1.89
74LS107N	.35
74LS112N	.35
74LS113N	.35
74LS132N	.72
74LS136N	.35
74LS151N	.67
74LS155N	.67
74LS157N	.67
74LS162N	.91
74LS163N	.91
74LS174N	.95
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LM320K-15	1.35
LM320T-5	1.60
LM320T-8	1.60
LM320T-12	1.50
LM320T-15	1.60
LM324N	1.15
LM339N	1.55
LM340K-5	1.10
LM340K-8	1.10
LM340K-12	1.10
LM340K-15	1.10
LM340K-24	1.10
LM340T-5	1.10
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LM340T-15	1.10
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LM381	1.60
LM382	1.60
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LM741CH	.35
LM741N	.25
LM747H/N	.62
LM748N	.35
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78L08	.60
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CD4012	.21
CD4013	.36
CD4014	.86
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CD4016	.36
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CD4019	.21
CD4020	1.02
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CD4022	.86
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CD4024	.75
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CD4026	1.51
CD4027	.36
CD4028	.79
CD4029	1.02
CD4030	.21
CD4035	1.02
CD4040	1.02
CD4042	.71
CD4043	.63
CD4044	.63
CD4046	1.67
CD4049	.36
CD4050	.36
CD4051	1.13
CD4060	1.42
CD4066	.71
CD4068	.40
CD4069	.40
CD4070	.40
CD4071	.21
CD4072	.21
CD4073	.21
CD4075	.21
CD4076	1.75
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CD4081	.21
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PIN	1 UP	PIN	1UP
8	.15	22	.30
14	.18	24	.35
16	.20	28	.42
18	.27	36	.58
20	.29	40	.57

3 level wire wrap gold.
14 pin .25
2 level 14 pin ww .20

WIRE WRAP LEVEL 3

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16	.33	28	1.00
18	.57	40	1.23

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comp. w/spec./sock.

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2N3053	.40
2N3638	.25
2N3643	.25
2N3904	.18
2N3906	.18
2N3055	.69
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25 per type .025 350 piece pack
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DL727/728	CA/CC	.500	1.90
DL747/750	CA/CC	.600	1.95
DL750	CC	.600	1.95
FND359	CC	.357	.70
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6100		40V	3.00
6100		50V	3.00
7700		50V	2.50
8000		55V	2.50
9400		65V	3.00
10000		20V	2.50
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35000		25V	5.00
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16K Static RAM Kit	265.00
24K Static RAM Kit	423.00
32K Dynamic RAM Kit	310.00
64K Dynamic RAM Kit	470.00
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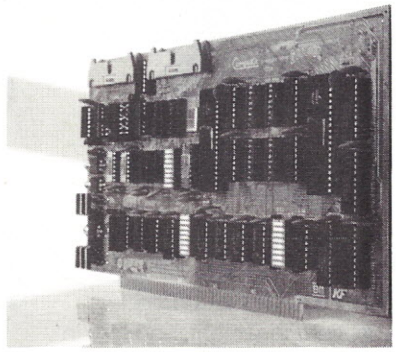
FREE: Send for your copy of our NEW 1978 QUEST CATALOG. Include 28¢ stamp.

NEW! the •FULL FUNCTION •DUAL CHANNEL S-100 I/O BOARD

$189 "unkit", $249 assembled

Our new I/O board gives you unparalleled flexibility and operating convenience . . . the specs speak for themselves:

- 2 independently addressable serial ports - dip switch selectable addresses
- Real LSI hardware UARTS for minimum CPU housekeeping
- RS232C, current loop (20 mA), and TTL and signals on both ports
- Precision, crystal-controlled baud rates up to 19.2 KBaud (individually dip switch selectable)
- Transmit and receive interrupts on both channels, jumperable to any vectored interrupt line
- Industry standard RS232 level converters with five RS232 handshaking lines per port
- Optically isolated current loop with provisions for both on-board, and off-board, current sources
- UART parameters, interrupt enables, and RS232 handshaking lines are software programmable, withpower-on hardware default to customer-specified hard-wired settings for maximum flexibility
- Port connectors mate directly to ribbon cable and DB25 connectors in standard pinouts
- RS232 lines will conform to either master or slave configurations
- Board gives full feature operation with both 2 and 4 MHz systems
- Low power consumption: +8V @ 450 mA max (350 mA typ); +16V @ 150 mA max (70 mA typ); −16V @ 70 mA max (55 mA typ)
- No software initialization required for board operation, although board parameters may be altered by software



Amazingly enough, all these features won't cost you more than other types of I/O boards that do a whole lot less. Visit your local computer store and see one in person, or order direct from us.

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We're happy to announce a new family of S-100 Econoram™ boards, each with two independently selectable banks – perfect for Alpha Micro Systems, Marinchip, and similarly structured machines. Low power, 4 MHz operation, and of course . . . completely static operation.

Name	Storage	Buss	Addressable on	Design	Unkit	Assm	CSC
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Econoram XII™	24K X 8	S-100	8K boundaries	static	**$479**	**$539**	**$649**
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Please note: CompuKit™ from **Godbout** boards are generally available in 3 forms: **unkit** (sockets, bypass caps pre-soldered in place for easy assembly); **assembled and tested**; or qualified under the **Certified System Component (CSC)** program (200 hour burn-in, guaranteed 4 MHz operation over the full commercial temperature range, and immediate replacement in event of failure within 1 year of invoice date).

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ECONORAM IV™	16K X 8	S-100	static	4 MHz	single 16K	**$295**	**$329**	**$429**
ECONORAM VI™	12K X 8	H8	static	2 MHz	1-8K, 1-4K	**$200**	**$270**	N/A
ECONORAM VII™	24K X 8	S-100	static	4 MHz	2-4K, 2-8K	**$445**	**$485**	**$605**
ECONORAM IX™	32K X 8	Dig Grp	static	4 MHz	2-4K, 1-8K, 1-16K	**$649**	**N/A**	**N/A**
ECONORAM X™	32K X 8	S-100	static	4 MHz	2-8K, 1-16K	**$599**	**$649**	**$789**
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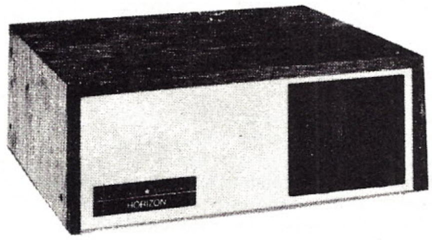

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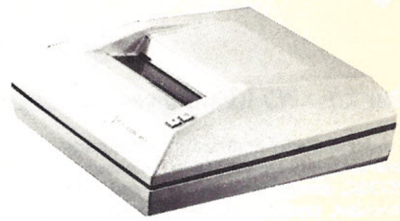

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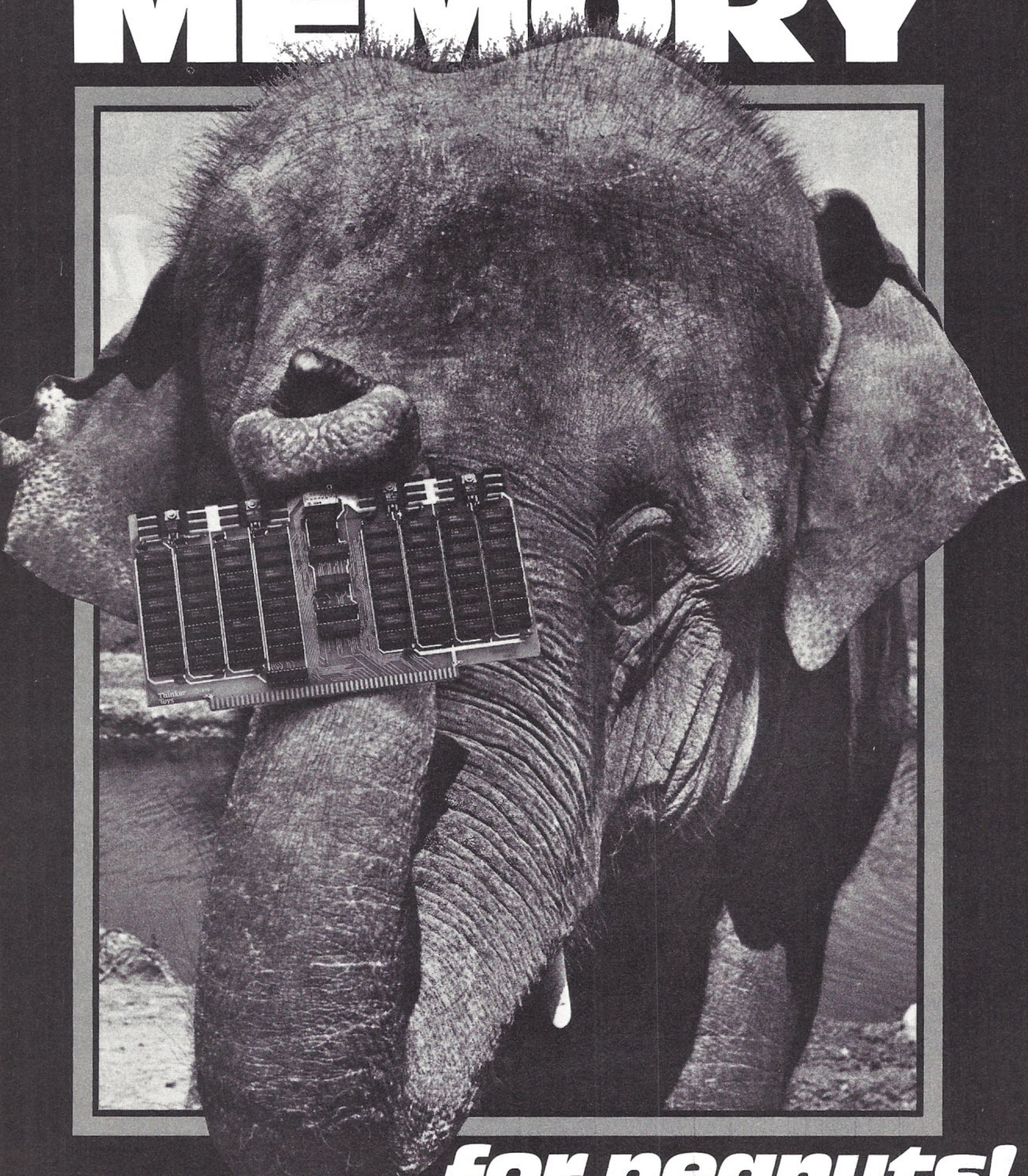

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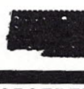

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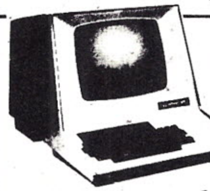

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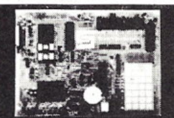

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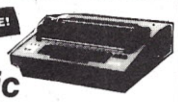

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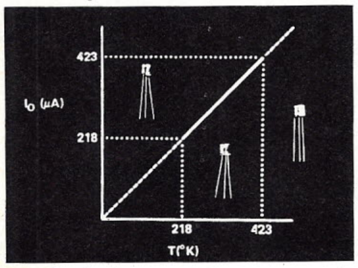

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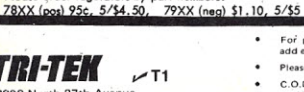

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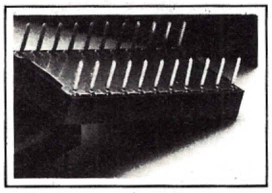

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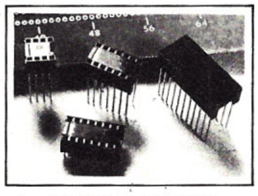
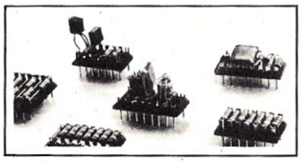
SKT-2802	28 pin	.43	.42	.41	.300
SKT-4002	40 pin	.59	.57	.55	.430



3 LEVEL WIRE WRAP GOLD
Sockets include features most desired by the electronics industry - gold over nickel plating, closed entry - removable covers and replaceable pins.

		1-9	10-24	25-99	100-999
SKT-0800	8 pin	.39	.38	.37	.32
SKT-1400	14 pin	.34	.33	.32	.30
SKT-1600	16 pin	.36	.35	.34	.32
SKT-1800	18 pin	.68	.67	.57	.52
SKT-2000	20 pin	.90	.86	.74	.67
SKT-2200	22 pin	.93	.90	.80	.70
SKT-2400	24 pin	.95	.89	.78	.72
SKT-2800	28 pin	1.20	1.04	.99	.92
SKT-4000	40 pin	1.53	1.45	1.35	1.19



DIP PLUGS

Use for mounting diodes, resistors, jumpers, etc.
Gold plated parts for ease of soldering and reliability.

	PLUGS			COVERS	
	1-24	25-49	50-99	1-24	25-99
8 pin	.43	.39	.38	.10	.09
14 pin	.45	.40	.37	.10	.09
16 pin	.47	.46	.45	.10	.09
24 pin	.75	.70	.67	.15	.13
40 pin	1.20	1.05	1.02	.25	.22

78P05SC 5V 10A TO-3 Reg.................... $12.95
21L02-4 (MM2102AN-4L 450nS) .... $ 1.44
Z80CPU I.C. $20.00
Z80ACPU I.C. $28.00
Z80CTC I.C. $11.00
Z80ACTC I.C. $16.00
Z80PIO I.C. $11.00
Z80APIO I.C. $16.00
25 Pin RS-232 connector Male............... $2.25
25 Pin RS-232 connector Female $3.25
DB-51226 Hood for RS-232 connector .... $ 1.39
D-20418 Screw Lock assembly .... $ 1.19
4801 4KX1 Static RAM $8.95, 8/ $60.00
4804 1KX4 Static RAM $8.95, 8/ $60.00

MICRO PROCESSOR COMPATIBLE A/D CONVERTERS
National Semi ADC3511 and 3711 are CMOS monolithic A/D converters. Pluse modulation analog-to-digital conversion is used and requires no external precision components except the reference voltage.

Single 5 volt operation. Operation with an isolated supply allows conversion of either polarity. Sign is automatically determined and indicated on the sign pin.

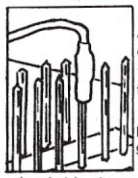
The ADC3511 and 3711 have been designed to provide address BCD data and are intended for use with micro processors and other digital systems. BCD digits are selected on demand via 2 Digit Select inputs. Digit Select inputs are latched. Start conversion input and conversion complete output are included on both types.

FEATURES
- .Single 5V Supply
- .ADC3511 3½ digits (0 to ± 1999 counts)
- .ADC3711 3 3/4 digits (0 to ± 3999 counts)
- .Addressed BCD Outputs
- .Easily interfaced to micro processor
- .TTL compatible

ADC-3511 (3-1/2 digit) $12.95
ADC-3711 (3-3/4 digit) $14.95
Spec for both parts........................... .80

POWER OP AMP
250mA output current capability. Operates on as low as 3V. Input parameters are programmable for system optimizing. Electronic shut down allows output to float. Packaged in 8 pin mini-dip.
LM13080N.................................. $1.94
Specs and applications...... .60

TRI-TEK



Jumper Kits for .025 Square Posts: All material for making jumpers for quick circuit changes and prototyping. Use for breadboarding, trouble shooting, field modifications. Fits standard IC socket wire/wrap posts. Excellent wiping action on gold plated box contacts. Kit contain 10 box contacts, heat shrinkable sleeving, and 5 feet of wire plus instruction sheet.
JCK-5101.... (5 double jumpers) $2.75, 4 kits/$10.00

uDP416 16K Dynamic RAM (200nS) 8/ $144.00
uDP416 16K Dynamic RAM (300nS) 8/ $128.00
6502 uProcessor.............................. $10.95

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Dozens of others-too many to list here and adding more each issue.

Yours for the Asking

TL497C SWITCHING REGULATOR
Switching regulator chip can convert from one voltage to another-either up or down!! Use this one to get positive or negative 12V from your +5V supply for those MOS parts. Starting with anywhere from +4.5V to +12V you can get from +30V down to -25V out. Adjustable output at up to 500mA. We are offering the chip plus a miniature inductor needed for the converter and spec sheet for only $9.50.
TL497C + inductor+spec............ $9.50

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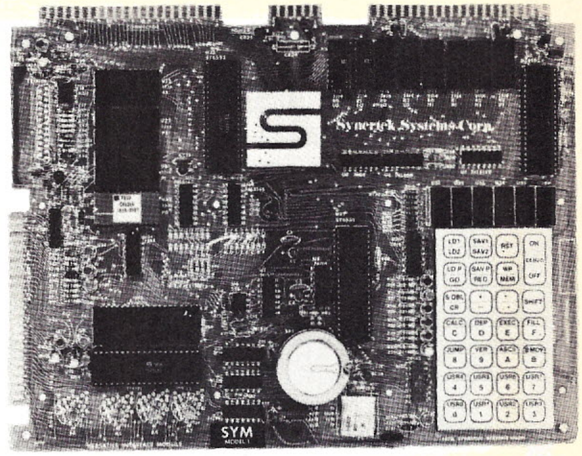
SYM-1, 6502-BASED MICROCOMPUTER



- FULLY-ASSEMBLED AND COMPLETELY INTEGRATED SYSTEM that's ready-to-use
- ALL LSI IC'S ARE IN SOCKETS
- 28 DOUBLE-FUNCTION KEYPAD INCLUDING UP TO 24 "SPECIAL" FUNCTIONS
- EASY-TO-VIEW 6-DIGIT HEX LED DISPLAY
- KIM-1* HARDWARE COMPATIBILITY
  The powerful 6502 8-Bit MICROPROCESSOR whose advanced architectural features have made it one of the largest selling "micros" on the market today.
- THREE ON-BOARD PROGRAMMABLE INTERVAL TIMERS available to the user, expandable to five on-board.
- 4K BYTE ROM RESIDENT MONITOR and Operating Programs.
- Single 5 Volt power supply is all that is required.
- 1K BYTES OF 2114 STATIC RAM onboard with sockets provided for immediate expansion to 4K bytes onboard, with total memory expansion to 65, 536 bytes.
- USER PROM/ROM: The system is equipped with 3 PROM/ROM expansion sockets for 2316/2332 ROMs or 2716 EPROMs
- ENHANCED SOFTWARE with simplified user interface
- STANDARD INTERFACES INCLUDE:
  - —Audio Cassette Recorder Interface with Remote Control (Two modes: 135 Baud KIM-1* compatible, Hi-Speed 1500 Baud)
  - —Full duplex 20mA Teletype Interface
  - —System Expansion Bus Interface
  - —TV Controller Board Interface
  - —CRT Compatible Interface (RS-232)
- APPLICATION PORT: 15 Bi-directional TTL Lines for user applications with expansion capability for added lines
- EXPANSION PORT FOR ADD-ON MODULES (51 I/O Lines included in the basic system)
- SEPARATE POWER SUPPLY connector for easy disconnect of the d-c power
- AUDIBLE RESPONSE KEYPAD

Synertek has enhanced KIM-1* software as well as the hardware. The software has simplified the user interface. The basic SYM-1 system is programmed in machine language. Monitor status is easily accessible, and the monitor gives the keypad user the same full functional capability of the TTY user. The SYM-1 has everything the KIM-1* has to offer, plus so much more that we cannot begin to tell you here. So, if you want to know more, the SYM-1 User Manual is available, separately.

SYM-1 Complete w/manuals	**$269.00**
SYM-1 User Manual Only	**7.00**
SYM-1 Expansion Kit	**75.00**

Expansion includes 3K of 2114 RAM chips and 1-6522 I/O chip.

SYM-1 Manuals: The well organized documentation package is complete and easy-to-understand.

SYM-1 CAN GROW AS YOU GROW. Its the system to BUILD-ON. Expansion features that are soon to be offered:

8K Basic ROM (Microsoft Basic)	**$159.00**
KTM-2 (Complete terminal less monitor)	**349.00**

QUALITY EXPANSION BOARDS DESIGNED SPECIFICALLY FOR KIM-1, SYM-1 & AIM 65

These boards are set up for use with a regulated power supply such as the one below, but, provisions have been made so that you can add onboard regulators for use with an unregulated power supply. But, because of unreliability, we do not recommend the use of onboard regulators. All I.C.'s are socketed for ease of maintenance. *All boards carry full 90-day warranty.*

All products that we manufacture are designed to meet or exceed industrial standards. All components are first qualtiy and meet full manufacturer's specifications. All this and an extended burn-in is done to reduce the normal percentage of field failures by up to 75%. To you, this means the chance of inconvenience and lost time due to a failure is very rare; but, if it should happen, we guarantee a turn-around time of less than forty-eight hours for repair.

Our money back guarantee: If, for any reason you wish to return any board that you have purchased directly from us within ten (10) days after receipt, complete, in original condition, and in original shipping carton; we will give you a complete credit or refund less a $10.00 restocking charge per board.

VAK-1 8-SLOT MOTHERBOARD

This motherboard uses the KIM-4* bus structure. It provides eight (8) expansion board sockets with rigid card cage. Separate jacks for audio cassette, TTY and power supply are provided. Fully buffered bus.

VAK-1 Motherboard	**$129.00**

VAK-2/4 16K STATIC RAM BOARD

This board using 2114 RAMs is configured in two (2) separately addressable 8K blocks with individual write-protect switches.

VAK-2 16K RAM Board with only 8K of RAM (½ populated)	**$239.00**
VAK-3 Complete set of chips to expand above board to 16K	**$175.00**
VAK-4 Fully populated 16K RAM	**$379.00**

VAK-5 2708 EPROM PROGRAMMER

This board requires a +5 VDC and $\pm$12 VDC, but has a DC to DC multiplyer so there is no need for an additional power supply. All software is resident in on-board ROM, and has a zero-insertion socket.

VAK-5 2708 EPROM Programmer	**$269.00**

VAK-6 EPROM BOARD

This board will hold 8K of 2708 or 2758, or 16K of 2716 or 2516 EPROMs. *EPROMs not included.*

VAK-6 EPROM Board	**$129.00**

VAK-7 COMPLETE FLOPPY-DISK SYSTEM (May '79)

VAK-8 PROTYPING BOARD

This board allows you to create your own interfaces to plug into the motherboard. Etched circuitry is provided for regulators, address and data bus drivers; with a large area for either wire-wrapped or soldered IC circuitry.

VAK-8 Protyping Board	**$49.00**

POWER SUPPLIES

ALL POWER SUPPLIES are totally enclosed with grounded enclosures for safety, AC power cord, and carry a full 2-year warranty.

FULL SYSTEM POWER SUPPLY

This power supply will handle a microcomputer and up to 65K of our VAK-4 RAM. ADDITIONAL FEATURES ARE: Over voltage Protection on 5 volts, fused, AC on/off switch. Equivalent to units selling for $225.00 or more.

Provides +5 VDC @ 10 Amps & $\pm$12 VDC @ 1 Amp

VAK-EPS Power Supply	**$125.00**

KIM-1* Custom P.S. provides 5 VDC @ 1.2 Amps and +12 VDC @ .1 Amps

KCP-1 Power Supply	**$41.50**

SYM-1 Custom P.S. provides 5 VDC @ 1.4 Amps

VCP-1 Power Supply	**$41.50**

*KIM is a product of MOS Technology

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MB-6A Basic 8KX8 ram uses 2102 type rams, S-100 buss. Kit 450 NSEC ......$123.95. PCBD.....$24.95

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MB-8A 2708 EROM Board, S-100, 8K8X or 16KX8 kit without PROMS $75.00 .... PCBD $28.95

MB-9 4KX8 RAM/PROM Board uses 2112 RAMS or 82S129 PROM kit without RAMS or PROMS $72.00

IO-2 S-100 8 bit parallel /IO port, ⅔ of boards is for kludging. Kit ....$46.00 PCBD........ $26.95

IO-4 Two serial I/O ports with full handshaking 20/60 ma current loop: Two parallel I/O ports.
Kit ....$130.00 PCBD $26.95

VB-1B 64 x 16 video board, upper lower case Greek, composite and parallel video with software, S-100.
Kit..............$125.00 PCBD $26.95

Altair Compatible Mother Board, 11 x 11½ x ⅛"
Board only ......$39.95. With 15 connectors.. $94.95

Extended Board full size. Board only .... $ 9.49
With connector $13.45

SP-1 Synthesizer Board S-100
PCBD.............. $42.95 KIT........ $135.95

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82S123	1.50	8080A	$ 9.95
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FDC-1 FLOPPY CONTROLLER BOARD will drive shugart, pertek, remic 5" & 8" drives up to 8 drives, on board PROM with power boot up, will operate with CPM (not incluided).
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QM-12 MOTHER BOARD, 13 slot, terminated, S-100 board only $34.95

CPU-1 8080A Processor board S-100 with 8 level vector interrupt PCBD $25.95

RTC-1 Realtime clock board. Two independent interrupts. Software programmable. PCBD $25.95

EPM-1 1702A 4K Eprom card PCBD $25.95

EPM-2 2708/2716 16K/32K
EPROM CARD PCBD $24.95

QM-9 MOTHER BOARD. Short Version of QM-12.
9 Slots PCBD $30.95

MEM-2 16K x 8 Fully Buffered
2114 Board PCBD $25.95

16K RAM BOARD by HWE fully buffered, bank select standard to IEE buss gold fingers, solder mask, plated thru holes, silk screened .... PCBD $25.95

KLUDGE BOARD by HWE for S-100 glass epoxy over 2600 plated through holes, 4 regulators with CAPS all S-100 functions labeled, gold fingers.
PCBD $29.95

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Kit $74.86

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MEM-2 with MIKOS #13 16K ram with L2114 250 NSEC **$269.95**

MEM-1 with MIKOS #1 450 NSEC 8K RAM **$123.95**

CPU-1 with MIKOS #2 8080A CPU **89.95**

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EMP-1 with MIKOS #10 4K 1702 less EPROMS **49.95**

EPM-2 with MIKOS #11 16-32K EPROMS less EPROMS **59.95**

QM-9 with MIKOS #12 9 slot mother board **75.00**

MIKOS PARTS ASSORTMENTS ARE ALL FACTORY PRIME PARTS. KITS INCLUDE ALL PARTS LISTED AS REQUIRED FOR THE COMPLETE KIT LESS PARTS LISTED. ALL SOCKETS INCLUDED.

VISA or MASTERCHARGE. Send account number, interbank number, expiration date and sign your order. Approx. postage will be added. Check or money order will be sent post paid in U.S. If you are not a regular customer, please use charge, cashier's check or postal money order. Otherwise there will be a two-week delay for checks to clear. Calif. residents add 6% tax. Money back 30 day guarantee. We cannot accept returned IC's that have been soldered to. Prices subject to change without notice. **$10 minimum order. $1.50 service charge on orders less than $10.00.**

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SN7417N	.25
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CD4016	.49
CD4017	1.19
CD4018	.99
CD4019	.49
CD4020	1.19
CD4021	1.39
CD4022	1.19
CD4023	.23
CD4024	.79
CD4025	.23
CD4026	2.25
CD4027	.69

CD4028	.89
CD4029	1.19
CD4030	.49
CD4035	.99
CD4040	1.19
CD4041	1.25
CD4042	.99
CD4043	.89
CD4044	.89
CD4046	1.79
CD4047	2.50
CD4048	1.35
CD4049	.49
CD4050	.49
CD4051	1.19
CD4053	1.19
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CD4059	9.95
CD4060	1.49
CD4066	.79
CD4068	.39
CD4069	.45

CD4070	.55
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74C20	.39
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74C73	.89
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74C85	2.49
74C90	1.95
74C93	1.95
74C95	1.95
74C107	1.25
74C151	2.90
74C154	3.00
74C157	2.15
74C160	2.49
74C161	2.49

74C163	2.49
74C164	2.49
74C173	2.60
74C192	2.49
74C193	2.49
74C195	2.49
74C922	5.95
74C923	6.25
74C925	8.95
74C926	8.95
80C95	1.50
80C97	1.50

LINEAR

78MG	1.75
LM106H	.99
LM300H	.80
LM301CN/H	.35
LM302H	.75
LM304H	1.00
LM305H	.60
LM307CN/H	.35
LM308CN/H	1.00
LM309H	1.10
LM309K	1.25
LM310CN	1.15
LM311N/H	.90
LM312H	1.95
LM317K	6.50
LM318CN/H	1.50
LM319N	1.30
LM320K-5	1.35
LM320K-5.2	1.35
LM320K-12	1.35
LM320K-15	1.35
LM320K-18	1.35
LM320K-24	1.35
LM320T-5	1.25
LM320T-5.2	1.25
LM320T-8	1.25
LM320T-12	1.25
LM320T-15	1.25
LM320T-18	1.25
LM320T-24	1.25
LM323K-5	5.95
LM324N	1.80
LM339N	.99
LM340K-5	1.35
LM340K-6	1.35
LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35

LM340K-18	1.35
LM340K-24	1.35
LM340T-5	1.25
LM340T-6	1.25
LM340T-8	1.25
LM340T-12	1.25
LM340T-15	1.25
LM340T-18	1.25
LM340T-24	1.25
LM358N	1.00
LM370N	1.95
LM373N	3.25
LM377N	4.00
LM380N	1.25
LM380CN	.99
LM381N	1.79
LM382N	1.79
NE501N	8.00
NE510A	6.00
NE529A	4.95
NE531H/V	3.95
NE536T	6.00
NE540L	6.00
NE544N	4.95
NE550N	1.30
NE555V	.39
NE556N	.99
NE560B	5.00
NE561B	5.00
NE562B	5.00
NE565N/H	1.25
NE566CN	1.75
NE567V/H	.99
NE570N	4.95
LM703CN/H	.69
LM709N/H	.29

LM710N	.79
LM711N	.39
LM723N/H	.55
LM733N	1.00
LM739N	1.19
LM741CN/H	.35
LM741-14N	.39
LM747N/H	.79
LM748N/H	.39
LM1310N	2.95
LM1458CN/H	.59
LM1488N	1.39
LM1489N	1.39
LM1496N	.95
LM1556V	1.75
MC1741SCP	3.00
LM2111N	1.95
LM2901N	2.95
LM3053N	1.50
LM3065N	1.49
LM3900N(3401)	.49
LM3905N	.89
LM3909N	1.25
MC5558V	.59
8038B	4.95
LM75450N	.49
75451CN	.39
75452CN	.39
75453CN	.39
75454CN	.39
75491CN	.79
75492CN	.89
75493N	.89
75494CN	.89
RC4136	1.25
RC4151	2.85
RC4194	5.95
RC4195	4.49

74LS00TTL

74LS00	.23
74LS01	.23
74LS02	.23
74LS03	.23
74LS04	.29
74LS05	.29
74LS08	.23
74LS09	.29
74LS10	.23
74LS11	.60
74LS13	.49
74LS14	.99
74LS15	.29
74LS20	.23
74LS21	.29
74LS22	.29
74LS26	.29
74LS27	.29
74LS28	.29
74LS30	.23
74LS32	.29
74LS37	.35
74LS40	.29
74LS42	.69

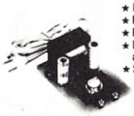
74LS47	.69
74LS51	.23
74LS54	.23
74LS55	.23
74LS73	.35
74LS74	.35
74LS75	.49
74LS76	.35
74LS78	.39
74LS83	.75
74LS85	.99
74LS86	.35
74LS90	.49
74LS92	.59
74LS93	.59
74LS95	.79
74LS96	.89
74LS107	.35
74LS109	.35
74LS112	.35
74LS123	.99
74LS125	.69
74LS132	.79
74LS136	.39

74LS138	.69
74LS139	.69
74LS151	.69
74LS155	.69
74LS157	.69
74LS160	.89
74LS161	.89
74LS162	.89
74LS163	.89
74LS164	.99
74LS175	.79
74LS181	2.49
74LS190	.89
74LS191	.89
74LS192	.89
74LS193	.89
74LS194	.89
74LS195	.89
74LS253	.79
74LS257	.69
74LS258	1.39
74LS260	.55
74LS279	.59
74LS367	.59
74LS368	.59
74LS670	1.95

Jameco ELECTRONICS New Kits

a division of JAMES ELECTRONICS of California

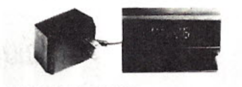
Regulated Power Supply



- ★ Uses LM 309K
- ★ Heat sink provided
- ★ P.C. board construction
- ★ Provides a solid 1 amp @ 5V
- ★ Includes components, hardware and instructions
- ★ Size: 3-1/2" x 5" x 2" high

JE200 5v 1amp $14.95

4-Digit Clock Kit



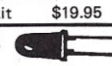
- ★ Bright .357" ht. red display
- ★ Sequential flashing colon
- ★ 12 or 24 hour operation
- ★ Extruded aluminum case (black)
- ★ Pressure switches for hours, minutes and hold functions
- ★ Includes all components, case and wall transformer
- ★ Size: 3-1/4" x 1-3/4" x 1-1/4"

JE730 $14.95

ALSO AVAILABLE:

JE900 - Digital Stopwatch kit $39.95 JE2206B Function Generator $19.95
JE701 - 6 Digit Clock kit $19.95 JE747 Jumbo 6 digit Clock kit $29.95

DISCRETE LEDS



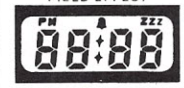
.200" dia.		
XC556R	red	5/$1
XC556G	green	4/$1
XC556Y	yellow	4/$1
XC556C	clear	4/$1
.200" dia.		
XC22R	red	5/$1
XC22G	green	4/$1
XC22Y	yellow	4/$1
.170" dia.		
MV10B	red	4/$1
.085" dia.		
MV50	red	6/$1

INFRA-RED LED 1/4"x1/4"x1/16" flat 5/$1

.125" dia.		
XC209R	red	5/$1
XC209G	green	4/$1
XC209Y	yellow	4/$1
.185" dia.		
XC526R	red	5/$1
XC526G	green	4/$1
XC526Y	yellow	4/$1
XC526C	clear	4/$1
.190" dia.		
XC111R	red	5/$1
XC111G	green	4/$1
XC111Y	yellow	4/$1
XC111C	clear	4/$1

TIMEX T1001 LIQUID CRYSTAL DISPLAY

FIELD EFFECT



4 DIGIT – .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive $7.95
T1001A-Reflective 8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.99	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.99	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	1.30
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	2.10
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	2.10
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA3023T	2.56	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	.85	CA3401N	.49
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75

9374 7 seg. C.A. LED driver

CLOCK CHIPS

MM5309	$4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998A	4.95
MM5841	9.95

MOTOROLA

MC1408L7	$4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	$.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	$ .37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

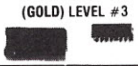
SOLDERTAIL STANDARD (TIN)

14 pin ST	$.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	$ .99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL STANDARD (GOLD)

8 pin SG	$.30	.27	.24
14 pin SG	.35	.32	.29
16 pin SG	.38	.35	.32
18 pin SG	.52	.47	.43
24 pin SG	$ .70	.63	.57
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3



8 pin WW	$.39	.38	.31
10 pin WW	.45	.41	.37
14 pin WW	.39	.38	.37
16 pin WW	.43	.42	.41
18 pin WW	.75	.68	.62
22 pin WW	$ .95	.85	.75
24 pin WW	1.05	.95	.85
28 pin WW	1.40	1.25	1.10
36 pin WW	1.59	1.45	1.30
40 pin WW	1.75	1.55	1.40

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 OHM / 27 OHM	12 OHM / 33 OHM	15 OHM / 39 OHM	18 OHM / 47 OHM	22 OHM / 56 OHM	50 PCS	$1.75
ASST. 2	5 ea.	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	50 PCS	1.75
ASST. 3	5 ea.	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	50 PCS	1.75
ASST. 4	5 ea.	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	50 PCS	1.75
ASST. 5	5 ea.	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	50 PCS	1.75
ASST. 6	5 ea.	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	50 PCS	1.75
ASST. 7	5 ea.	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

$10.00 Minimum Order — U.S. Funds Only Spec Sheets – 25¢
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74C922	Keyboard Encoder (16 keys)	5.95

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ICM7045	CMOS Precision Timer	24.95
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TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
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MM5330	4½ Digit DPM Logic Block	5.95
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Photo Transistor Opto-Isolator
(Same as MCT 2 or 4N25)
2/99¢

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SOUND GENERATOR
Generates Complex Sounds
Low Power - Programmable
3.95 each

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AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal includes score display, 6 games and select angles, etc. **7.95/set**

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XR556	.99
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XR1310P	1.30
XR1468CN	3.85
XR1488	1.39
XR1489	1.39

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XR2207	3.85
XR2208	5.20
XR2209	1.75
XR2211	5.25
XR2212	4.35
XR2240	3.45

XR2242CP	1.50
XR2264	4.25
XR2556	3.20
XR2567	2.99
XR3403	1.25
XR4136	1.25
XR4151	2.85
XR4194	4.95
XR4202	3.60
XR4212	2.05
XR4558	.75
XR4739	1.15
XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00
1N751	5.1	400m	4/1.00
1N752	5.6	400m	4/1.00
1N753	6.2	400m	4/1.00
1N754	6.8	400m	4/1.00
1N757	9.0	400m	4/1.00
1N759	12.0	400m	4/1.00
1N959	8.2	400m	4/1.00
1N965	15	400m	4/1.00
1N5232	5.6	500m	28
1N5234	6.2	500m	28
1N5235	6.8	500m	28
1N5236	7.5	500m	28
1N5242	12	500m	28
1N5245	15	500m	28
1N456	25	40m	6/1.00
1N458	150	7m	6/1.00
1N485A	180	10m	5/1.00
1N4001	50 PIV 1 AMP		12/1.00

TYPE	VOLTS	W	PRICE
1N4002	100 PIV 1 AMP		12/1.00
1N4003	200 PIV 1 AMP		12/1.00
1N4004	400 PIV 1 AMP		12/1.00
1N4005	600 PIV 1 AMP		10/1.00
1N4006	800 PIV 1 AMP		10/1.00
1N4007	1000 PIV 1 AMP		10/1.00
1N3600	50	200m	6/1.00
1N4148	75	10m	15/1.00
1N4154	35	10m	12/1.00
1N4305	75	25m	15/1.00
1N4734	5.6	1w	28
1N4735	6.2	1w	28
1N4736	6.8	1w	28
1N4738	8.2	1w	28
1N4742	12	1w	28
1N4744	15	1w	28
1N1183	50 PIV 35 AMP		1.60
1N1184	100 PIV 35 AMP		1.70
1N1185	150 PIV 35 AMP		1.70
1N1186	200 PIV 35 AMP		1.80
1N1188	400 PIV 35 AMP		3.00

SCR AND FW BRIDGE RECTIFIERS

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2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

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C106B1	.50
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MPSA05	5/1.00
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TIS98	6/1.00
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40410	1.75
40673	1.75
2N918	4/1.00
2N2219A	2/1.00
2N2221A	4/1.00
2N2222A	5/1.00
PN2222 Plastic	7/1.00
2N2369	5/1.00
2N2369A	4/1.00
MPS2369	5/1.00
2N2484	4/1.00
2N2906	4/1.00
2N2907	5/1.00
PN2907 Plastic	7/1.00
2N2925	5/1.00
MJE2955	1.25
2N3053	2/1.00

2N3055	.89
MJE3055	1.00
2N3392	5/1.00
2N3398	5/1.00
PN3567	3/1.00
PN3568	4/1.00
PN3569	4/1.00
MPS3638A	5/1.00
MPS3702	5/1.00
2N3704	5/1.00
MPS3704	5/1.00
2N3705	5/1.00
MPS3705	5/1.00
2N3706	5/1.00
MPS3706	5/1.00
2N3707	5/1.00
2N3711	5/1.00
2N3724A	.65
2N3725A	1.00
2N3772	2.25
2N3823	1.00
2N3903	5/1.00

2N3904	4/1.00
2N3905	4/1.00
2N3906	4/1.00
2N4013	3/1.00
2N4123	6/1.00
PN4249	4/1.00
PN4250	4/1.00
2N4400	4/1.00
2N4401	4/1.00
2N4402	4/1.00
2N4403	4/1.00
2N4409	5/1.00
2N5086	4/1.00
2N5087	4/1.00
2N5088	4/1.00
2N5089	4/1.00
2N5129	5/1.00
PN5134	5/1.00
PN5138	5/1.00
2N5139	5/1.00
2N5210	5/1.00
2N5449	3/1.00
2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100		1-9	10-99	100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

Transistor Checker

— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size: 3¾" x 6¼" x 2"
"C" cell battery not included.

Trans-Check **$29.95 ea.**

Custom Cables & Jumpers

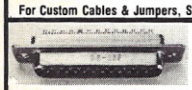
DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea.
DB25S-4-S	4 ft.	2-DP25S	$17.95 ea.

Dip Jumpers

DJ14-1	1 ft.	1-14 Pin	$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing



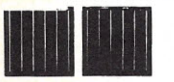
CONNECTORS
25 Pin-D Subminiature

DB25P (as pictured)	PLUG (Meets RS232)	$2.95
DB25S	SOCKET (Meets RS232)	$3.50
DB51226-1	Cable Cover for DB25P or DB25S	$1.75

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out — Bifuracted Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)		$1.95
18/36	PINS (Solder Eyelet)		$2.49
22/44	PINS (Solder Eyelet)		$2.95
50/100 (.100 Spacing)	PINS (Wire Wrap)		$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap)	R681-1	$6.95

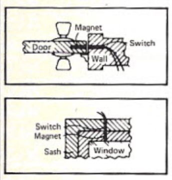


Solar Cells 2x2cm

- 0.4 volts
- 100mA
- 41 MW

Can be added in series for higher voltage or parallel for higher current.

#SC 2x2 **$1.95 ea. or 3/$5.00**

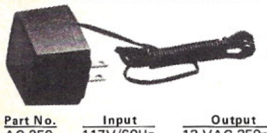


Magnetically Activated Switch

The 9250-0002 is a single pole normally closed switch. When the magnet is engaged, the circuit is open. This switch is only suitable for use in non-magnetic doors and windows.

#9250-0002 **2/$1.00**

AC Wall Transformer



Ideal for use with clocks, power supplies or any other type of AC application.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12 VAC 250mA	$3.95
AC 500	117V/60Hz	12 VAC 500mA	$4.95

REMOTE CONTROL TRANSMITTER & RECEIVER

- CAN BE USED AS REMOTE CONTROL FOR TV
- USE IT FOR YOUR OWN GARAGE DOOR OPENER
- TRANSMITS BETWEEN 38KHz AND 41.5KHz
- THOUSANDS OF USES FOR REMOTE CONTROL APPLICATIONS
- TRANSMITTER USES A 1.5V BATTERY
- SCHEMATIC INCLUDED

$19.95

INSTRUMENT/CLOCK CASE

This case is an injection molded unit that is ideal for uses such as DVM, COUNTER, or CLOCK cases. It has dimensions of 4½" in length by 4" in width by 1-9/16" in height. It comes complete with a red bezel.

PART NO: IN-CC $3.49 each

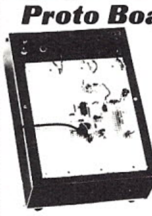
MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		
8080A	CPU	$ 9.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	5.95
8238	System Controller	5.95
8251	Prog. Comm. I/O (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/O (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95
6800/6800 SUPPORT DEVICES		
MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25
MICROPROCESSOR CHIPS—MISCELLANEOUS		
Z80(780C)	CPU	$19.95
Z80A(780-1)	CPU	24.95
CDP1802	CPU	19.95
2650	MPU	19.95
8035	8-Bit MPU w/clock, RAM, I/O lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95
SHIFT REGISTERS		
MM500H	Dual 25 Bit Dynamic	$.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	1.95
UART'S		
A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS			
M-Z80	User Manual		$7.50
M-CDP1802	User Manual		7.50
M-2650	User Manual		5.00
ROM'S			
2513(2140)	Character Generator(upper case)		$9.95
2513(3021)	Character Generator(lower case)		9.95
2516	Character Generator		10.95
MM5230N	2048-Bit Read Only Memory		1.95
RAM'S			
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	9.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	14.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00
PROM'S			
1702A	2048	FAMOS	$5.95
TMS2516 (2716)	16K*	EPROM(Intel 2716) *Requires single +5V power supply	49.95
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM **Requires 3 voltages, —5V, +5V, +12V	29.95
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

CSC CONTINENTAL SPECIALTIES
PROTO BOARDS

Proto Board 203

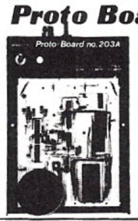


A total ready-to-use power breadboard prototest device with a built-in regulated, short-proof power supply. Just plug-in and start building! 2 extra floating 5-way binding posts for external signals. Self-contained with power switch indicator lamp and power fuse. 24-14 pin DIP capacity. Attractive two-tone quality case. All metal construction.
9¾"L x 6½"W x 2¾"H
5 lbs.

PB 203 **$75.00**

Model Number	L x W x H (Inches)	Price
PB-6	6.0 x 4.5 x 1.4	$15.95
PB-100	6.0 x 4.5 x 1.4	$19.95
PB-101	6.0 x 4.5 x 1.4	$22.95

Proto Board 203A



All the features of the PB-203 plus additional power supply flexibility, provides 1%-Regulated 5VDC supply (same specifications as PB-203). Regulated separate +15VDC and −15 VDC 0.5A supplies, each with internally and independently adjustable output voltage. Ripple and noise of + and −15V supplies. 10mV at 0.25A.

PB 203A **$124.95**

Model Number	L x W x H (Inches)	Price
PB-102	7.0 x 4.5 x 1.4	$26.95
PB-103	9.0 x 6.0 x 1.4	$44.95
PB-104	9.8 x 8.0 x 1.4	$54.95

B+K PRECISION 3½-Digit Portable DMM

- Overload Protected
- .3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv, 1Va, 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage 0-1000V/
AC Voltage: 0-1000V
Freq. Response: 50-400 HZ
DC/AC Current: 0-100mA
Resistance: 0-10 meg ohm
Size: 6.4" x 4.4" x 2"

Model 2800 $99.95
Comes with test leads, operating manual and spare fuse.

Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC CONTINENTAL SPECIALTIES CORPORATION 100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator
use power from car battery — **Model 100 — CLA $3.95**
Charger/Eliminator
use 110 V AC — **Model 100 — CAI $9.95**

New CSC Mini-Max 6 Digit 50MHz Frequency Counter

- Guaranteed frequency range of 100 Hz to 50 MHz
- Full 6 digit display with antiglare window
- Fully automatic-range, polarity, slope, trigger, input level switching not required.
- Lead-zero blanking—All zeros to the left of the first non-zero digit are blanked. Kilo Hertz and Mega Hertz decimal points automatically light up when the unit is turned on.
- Built in input overvoltage protection.
- Use 9V Battery or 110/220V power.
- Complete with mini antenna.
- Lightweight — Only 8oz.

MINI-MAX $89.95

Accessories For Mini-Max

Part No.	Description	Price
MM-A4	Antenna	$ 3.95
MM-C5	Carrying case	5.95
MM-IPC	Input cable with clip leads	3.95
MM-AC2	110V adapter	9.95
MM-AC3	220V adapter	9.95

$10.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets — 25¢
1979 Catalog Available—Send 41¢ stamp

NEW 1979 Catalog

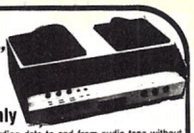
Jameco ELECTRONICS
a division of JAMES ELECTRONICS of California

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
ADVERTISED PRICES GOOD THRU APRIL

J1

The Incredible "Pennywhistle 103"



$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modern and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method .....Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate ....300 Baud.
Data Format ....Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies ...2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies ..Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark.
Receive Sensitivity ....−46 dbm accoustically coupled.
Transmit Level ....−15 dbm nominal. Adjustable from −6 dbm to −20 dbm.
Receive Frequency Tolerance ...Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface ....EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements ....120 VAC, single phase, 10 Watts.
Physical ....All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

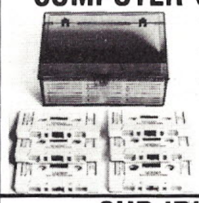
TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:
* 8 each UPD416 (16K Dynamic Rams)
* Documentation for conversion

TRS-16K $115.00

Special Offer - Order both your TRS-16K and the Sup'R' MOD II Interface kit together (retail value $144.95) **for only $139.95**

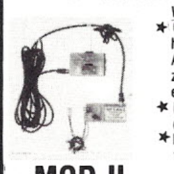
COMPUTER CASSETTES



- 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- PLASTIC CASE INCLUDED 12 CASSETTE CAPACITY
- ADDITIONAL CASSETTES AVAILABLE #C-15-$2.50 ea

CAS-6 $14.95
(Case and 6 Cassettes)

SUP 'R' MOD II
UHF Channel 33 TV Interface Unit Kit

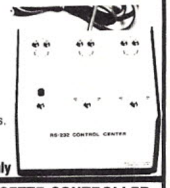


Wide Band B/W or Color System
- Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, IRS-80, Challenger, etc.
- MOD II is pretuned to Channel 33 (UHF).
- Includes coaxial cable and antenna transformer.

MOD II $29.95 Kit

RS-232 CONTROL CENTER

Plug in your modem, computer prom programmer, terminal, printer, etc. and selectively control data flow.



- Same Contour as "Pennywhistle 103"
- Totally self-contained
- Includes 2 master ports and 3 slave ports.

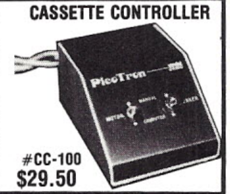
PART NO. RS-232CC $89.95 kit only

CASSETTE CONTROLLER

Ideal for use with the TRS 80 and others.

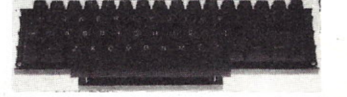
"Plug/Jack interface to any computer system requiring remote control of cassette functions"

The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.



#CC-100 $29.50

63-Key Unencoded Keyboard



This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **$29.95/each**

Hexadecimal Unencoded Keypad

19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

Reader Service—see page 179

DIODES/ZENERS

QTY.				
	1N914	100v	10mA	.05
	1N4005	600v	1A	.08
	1N4007	1000v	1A	.15
	1N4148	75v	10mA	.05
	1N4733	5.1v	1 W Zener	.25
	1N753A	6.2v	500 mW Zener	.25
	1N758A	10v	"	.25
	1N759A	12v	"	.25
	1N5243	13v	"	.25
	1N5244B	14v	"	.25
	1N5245B	15v	"	.25

SOCKETS/BRIDGES

QTY.					
	8-pin	pcb	.20	ww	.35
	14-pin	pcb	.20	ww	.40
	16-pin	pcb	.20	ww	.40
	18-pin	pcb	.25	ww	.95
	20-pin	pcb	.35	ww	.95
	22-pin	pcb	.35	ww	.95
	24-pin	pcb	.35	ww	.95
	28-pin	pcb	.45	ww	1.25
	40-pin	pcb	.50	ww	1.25
	Molex pins	.01	To-3 Sockets		.25
	2 Amp Bridge		100-prv		.95
	25 Amp Bridge		200-prv		1.50

TRANSISTORS, LEDS, etc.

QTY.			
	2N2222	(2N2222 Plastic .10)	.15
	2N2222A		.19
	2N2907A	PNP	.19
	2N3906	PNP (Plastic Unmarked)	.10
	2N3904	NPN (Plastic Unmarked)	.10
	2N3054	NPN	.45
	2N3055	NPN 15A 60v	.60
	T1P125	PNP Darlington	1.95
	LED Green,	Red, Clear, Yellow	.15
	D.L.747	7 seg 5/8" High com-anode	1.95
	MAN72	7 seg com-anode (Red)	1.25
	MAN3610	7 seg com-anode (Orange)	1.25
	MAN82A	7 seg com-anode (Yellow)	1.25
	MAN74	7 seg com-cathode (Red)	1.50
	FND359	7 seg com-cathode (Red)	1.25

9000 SERIES

QTY.			QTY.		
	9301	.85		9322	.65
	9309	.35		9601	.20
	9316	1.10		9602	.45

MICRO'S, RAMS, CPU'S, E-PROMS

QTY.			QTY.		
	8T13	1.50		2107B-4	4.95
	8T23	1.50		2114	9.50
	8T24	2.00		2513	6.25
	8T97	1.00		2708	10.50
	74S188	3.00		2716 D.S.	34.00
	1488	1.25		2716 (5v)	59.00
	1489	1.25		2758 (5v)	23.95
	1702A	4.50		3242	10.50
	AM 9050	4.00		4116	11.50
				6800	13.95
	MM 5314	3.00		6850	7.95
	MM 5316	3.50		8080	7.50
	MM 5387	3.50		8212	2.75
	MM 5369	2.95		8214	4.95
	TR 1602B	3.95		8216	3.50
	UPD 414	4.95		8224	3.25
	Z 80 A	22.50		8228	6.00
	Z 80	17.50		8251	7.50
	Z 80 PIO	10.50		8253	18.50
	2102	1.45		8255	8.50
	2102L	1.75		TMS 4044	9.95

C MOS

QTY.		
	4000	.15
	4001	.15
	4002	.20
	4004	3.95
	4006	.95
	4007	.20
	4008	.75
	4009	.35
	4010	.35
	4011	.20
	4012	.20
	4013	.40
	4014	.75
	4015	.75
	4016	.35
	4017	.75
	4018	.75
	4019	.35
	4020	.85
	4021	.75
	4022	.75
	4023	.20
	4024	.75
	4025	.20
	4026	1.95
	4027	.35
	4028	.75
	4029	1.15
	4030	.30
	4033	1.50
	4034	2.45
	4035	.75
	4037	1.80
	4040	.75
	4041	.69
	4042	.65
	4043	.50
	4044	.65
	4046	1.25
	4048	.95
	4049	.45
	4050	.45
	4052	.75
	4053	.75
	4066	.55
	4069/74C04	.35
	4071	.25
	4081	.30
	4082	.30
	4507	.95
	4511	.95
	4512	1.10
	4515	2.95
	4519	.85
	4522	1.10
	4526	.95
	4528	1.10
	4529	.95
	MC14409	14.50
	MC14419	4.85
	74C151	1.50

LINEARS, REGULATORS, etc.

QTY.			QTY.			QTY.		
	MCT2	.95		LM323K	5.95		LM380 (8-14 Pin)	1.19
	8038	3.95		LM324	1.25		LM709 (8-14 Pin)	.35
	LM201	.75		LM339	.75		LM711	.45
	LM301	.45		7805 (340T5)	.95		LM723	.40
	LM308	.65		LM340T12	.95		LM725	2.50
	LM309H	.65		LM340T15	.95		LM739	1.50
	LM309K (340K-5)	1.50		LM340T18	.95		LM741 (8-14)	.35
	LM310	.85		LM340T24	.95		LM747	1.10
	LM311D	.75		LM340K12	1.25		LM1307	1.25
	LM318	1.75		LM340K15	1.25		LM1458	.65
	LM320H6	.79		LM340K18	1.25		LM3900	.50
	LM320H15	.79		LM340K24	1.25		LM75451	.65
	LM320H24	.79		LM373	2.95		NE555	.45
	7905 (LM320K5)	1.65		LM377	3.95		NE556	.85
	LM320K12	1.65		78L05	.75		NE565	.95
	LM320K24	1.65		78L12	.75		NE566	1.25
	LM320T5	1.65		78L15	.75		NE567	.95
	LM320T12	1.65		78M05	.75			
	LM320T15	1.65						

— TTL —

QTY.			QTY.			QTY.			QTY.		
	7400	.10		7482	.75		74221	1.00		74LS02	.30
	7401	.15		7483	.75		74367	.95		74LS04	.30
	7402	.15		7485	.55		75108A	.35		74LS05	.35
	7403	.15		7486	.25		75491	.50		74LS08	.35
	7404	.10		7489	1.05		75492	.50		74LS09	.35
	7405	.25		7490	.45		74H00	.15		74LS10	.35
	7406	.25		7491	.70		74H01	.20		74LS11	.35
	7407	.55		7492	.45		74H04	.20		74LS20	.30
	7408	.15		7493	.35		74H05	.20		74LS21	.35
	7409	.15		7494	.75		74H08	.35		74LS22	.35
	7410	.15		7495	.60		74H10	.35		74LS32	.35
	7411	.25		7496	.80		74H11	.25		74LS37	.35
	7412	.25		74100	1.15		74H15	.45		74LS38	.45
	7413	.25		74107	.25		74H20	.25		74LS40	.40
	7414	.75		74121	.35		74H21	.25		74LS42	.75
	7416	.25		74122	.55		74H22	.40		74LS51	.45
	7417	.40		74123	.35		74H30	.20		74LS74	.45
	7420	.15		74125	.45		74H40	.25		74LS76	.50
	7426	.25		74126	.35		74H50	.25		74LS86	.45
	7427	.25		74132	.75		74H51	.25		74LS90	.65
	7430	.15		74141	.90		74H52	.15		74LS93	.65
	7432	.20		74150	.85		74H53	.25		74LS107	.50
	7437	.20		74151	.65		74H55	.20		74LS123	1.20
	7438	.20		74153	.75		74H72	.35		74LS151	.85
	7440	.20		74154	.95		74H74	.35		74LS153	.85
	7441	1.15		74156	.70		74H101	.75		74LS157	.85
	7442	.45		74157	.65		74H103	.55		74LS160	.95
	7443	.45		74161	.55		74H106	.95		74LS164	1.20
	7444	.45		74163	.85		74L00	.25		74LS193	1.05
	7445	.65		74164	.60		74L02	.20		74LS195	.95
	7446	.70		74165	1.10		74L03	.25		74LS244	1.70
	7447	.70		74166	1.25		74L04	.30		74LS367	.95
	7448	.50		74175	.80		74L10	.20		74LS368	.95
	7450	.25		74176	.85		74L20	.35		74S00	.35
	7451	.25		74180	.55		74L30	.45		74S02	.35
	7453	.20		74181	2.25		74L47	1.95		74S03	.25
	7454	.25		74182	.75		74L51	.45		74S04	.25
	7460	.40		74190	1.25		74L55	.65		74S05	.35
	7470	.45		74191	1.25		74L72	.45		74S08	.35
	7472	.40		74192	.75		74L73	.40		74S10	.35
	7473	.25		74193	.85		74L74	.45		74S11	.35
	7474	.30		74194	.95		74L75	.85		74S20	.25
	7475	.35		74195	.95		74L93	.55		74S40	.20
	7476	.40		74196	.95		74L123	.85		74S50	.20
	7480	.55		74197	.95		74LS00	.30		74S51	.25
	7481	.75		74198	1.45		74LS01	.30		74S64	.15
										74S74	.35
										74S112	.60
										74S114	.65
										74S133	.40
										74S140	.55
										74S151	.30
										74S153	.35
										74S157	.75
										74S158	.30
										74S194	1.05
										74S257 (8123)	1.05
										8131	2.75

19

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- Rechargeable batteries and charger included
- Measures DC Volts, AC Volts, Ohms and Current
- Automatic polarity, decimal and overload indication
- No zero adjustment and no full-scale ohms adjust
- Battery-operated — NiCad batteries; also AC line operation.
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  Tilt stand option .... $ 3.50
- Leather case $20.00

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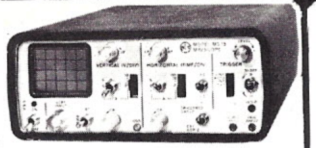

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MS-15
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With Rechargeable Batteries & Charger Unit

- 15 megahertz bandwidth.
- External and internal trigger.
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- Power consumption < 15 watts.
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- Parts & Labor guaranteed 1 year
- 10 to 1, 10 meg probe .... $27.
- Leather carrying case .... $45.

PROBE 1¢

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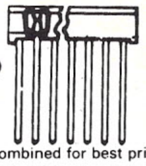
PROBE 1¢ with the purchase of SCOPE and the MENTION of this MAGAZINE

- MS-215 Dual Trace Version of MS-15 **$435.**

3 LEVEL GOLD WIRE WRAP SOCKETS

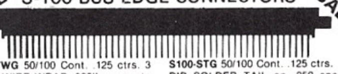


Sockets purchased in multiples of 50 per type may be combined for best price.

	1-24	25-49	50-99	100-249	250-999	1K-5K
8 pin*	.41	.38	.35	.31	.27	.23
14 pin*	.39	.38	.36	.32	.29	.27
16 pin*	.43	.42	.39	.35	.32	.30
18 pin	.63	.58	.54	.47	.42	.36
20 pin	.80	.75	.70	.63	.58	.53
22 pin*	.90	.85	.80	.70	.61	.57
24 pin	.90	.84	.78	.68	.63	.58
28 pin	1.10	1.00	.90	.84	.76	.71
40 pin	1.50	1.40	1.30	1.20	1.04	.89

All sockets are GOLD 3 level closed entry *End and side stacable. 2 level, Solder Tail, Low Profile, Tin Sockets and Dip Plugs available. CALL FOR QUOTATION

SALE S-100 BUS EDGE CONNECTORS SALE



S100-WWG 50/100 Cont. .125 ctrs. 3 LEVEL WIRE WRAP .025" sq. posts on .250 spaced rows. GOLD plated.

1-4	5-9	10-24
$4.00	$3.75	$3.50

S100-STG 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .250 spaced rows for VECTOR and MASI motherboards GOLD plated.

1-4	5-9	10-24
$3.50	$3.25	$3.00

RG81G 50/100 Cont. .125 ctrs. DIP SOLDER TAIL on .140 spaced rows for ALTAIR motherboards. GOLD plated.

1-4	5-9	10-24
$5.00	$4.75	$4.50

R681-3 50/100 Cont. .125 ctrs. PIERCED SOLDER EYELET tails. GOLD.
$7.53

Other Popular Edge Connectors

R644-G 22/44 Cont. .156 ctrs. PIERCED SOLDER EYLET tails. GOLD plated.

1-4	5-9	10-24
$3.00	$2.75	$2.50

R644-3 22/44 Cont. .156 ctrs. WIRE WRAP tails. GOLD.

1-4	5-9	10-24
$4.00	$3.75	$3.50

CG-1 IMSAI Style Card Guides 5/$1.00
ATTN: OEM's and Dealers, many other connectors available call or quotation.

LIQUID CRYSTAL DIGITAL CLOCK-CALENDAR

- For Auto, Home, Office
- Small in size (2x2½x½)
- Push button for seconds release for date.
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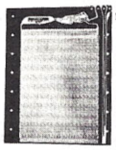
- 2 MODELS AVAILABLE:
  LCD-101, portable model runs on self-contained batteries for better than a year.
  LCD-102, runs on 12 Volt system and is back-lighted.
- LCD-101 or LCD-102 your choice .... $34.95 ea.
- Clear desk stand for $2.00

8803 MOTHER BOARD FOR S100 BUS MICRO-COMPUTERS

Vector



- Kit includes 12 tantalum capacitors for +5, +12, —12 buses and insulated mounting spacers.
- Wiring side shown. Component side bare epoxy glass with white markings for component locations.
- G10 epoxy glass board with 2 ounce copper, solder plated and .038 diameter holes for leads.
- Solder mask with solder windows on etched circuits to avoid accidental short circuits.
- Mounts 11 receptacles with 100 contacts (2 rows) on .125 centers with .250 row spacing, Vector part number R681-2; or mounts 10 receptacles plus interconnections to smaller mother board for expansion.
- Includes etched circuits and instructions for option of active, pull-up, or floating terminations.
- Large buses: +5V and GND (10 AMPS), ± 12V or 16V (7 AMPS). Current ratings are per MIL-STD-275 with 10°C rise
- Fits in Vector-pak enclosures.
- Fits in IMSAI 8080 microcomputer as expander board.

Price: $29.50

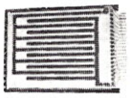
Vector Plugboards

8800V
Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware. 5.3" x 10" x 1/16"

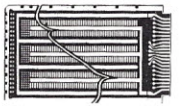
1-4	5-9	10-24
$19.95	$17.95	$15.96

8801-1
Same as 8800V except plain; less power buses & heat sink.

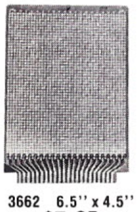
1-4	5-9	10-24
$14.95	$13.46	$11.96



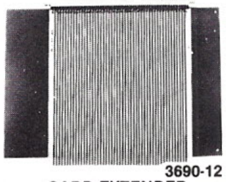
3682 9.6" x 4.5"
$10.97
3682-2 6.5" x 4.5"
$9.81
Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156



3677 9 6" x 4.5"
$10.90
3677-2 6.5" x 4.5"
$9.74
Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156



3662 6.5" x 4.5"
$7.65
3662-2 9.6" x 4.5"
$11.45
P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156



3690-12
CARD EXTENDER
Card Extender has 100 contacts 50 per side on .125 centers-Attached connector-is compatible with S-100 Bus Systems. **$25.83**
3690 6.5" 22/44 pin .156 ctrs. Extenders $13.17

1/16 Vector BOARD

.042 dia holes on 0.1 spacing for IC's

Phenolic PART NO.	SIZE	PRICE 1-9	10-19
64P44XXXP	4.5x6.5"	$1.56	$1.40
169P44XXXP	4.5x17"	$3.69	$3.32
Epoxy Glass			
64P44	4.5x6.5"	$1.79	$1.61
84P44	4.5x8.5"	$2.21	$1.99
169P44	4.5x17"	$4.52	$4.07
169P84	8.5x17"	$8.03	$7.23

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4116's RAMS
(16Kx1 200ns)

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2708

8K 450 ns

EPROM
FACTORY PRIME
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25 + *Call For Price*

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WOW

14 - G3 100 for **$30.00**
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50 of each for **$32.00**

Sockets are End & Side stackable, closed entry

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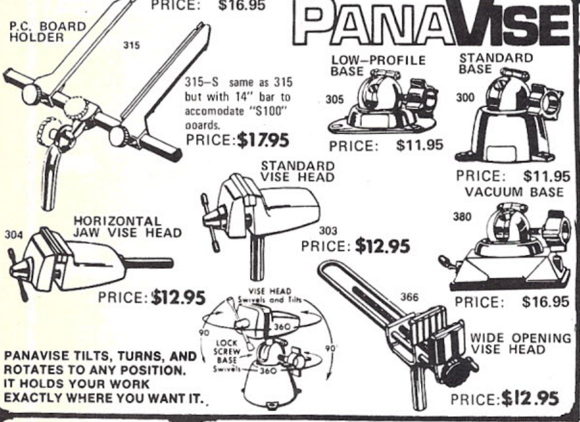

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FND 510
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½" 7 seg LED
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10/$4.50

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for .042 dia. holes
(all boards on this page)
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A-13 hand installing tool .... **$ 2.94**

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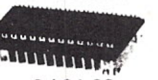
24 PIN DIP PLUGS WITH COVERS



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High speed logic probe. Captures pulses as short as 10 ns. **Input Impedance:** 500,000 ohms. **Minimum Detectable Pulse:** 10 ns. **Maximum Input Signal (Frequency):** 50 MHz. **Pulse Detector (LED):** High speed train or single event. **Pulse Memory:** Pulse or level transition detected and stored.
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3-LEVEL GOLD WIRE WRAP SOCKETS

14 PIN	39¢ each
16 PIN	43¢ each

100 for $30.00

Sockets are end and side stackable, closed entry.

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10 for $40.00

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Kit $8.95

JADE PARALLEL/SERIAL INTERFACE

S-100 compatible, 2 serial I/O ports, 1 parallel I/O.

Kit JG-P/S	$124.95
Assembled & Tested: JG-P/SA	$179.95
Bare Board w/Manual	$ 30.00

JADE Products

"KANSAS CITY STANDARD" TAPE INTERFACE
Part No. 111
Board $7.60; with parts $27.50

RS-232/TTL INTERFACE
Part No. 232
Converts TTL to RS-232 and RS-232 to TTL
Board only $4.50; with parts $7.00

RS-232/TTY INTERFACE
Part No. 600
Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232
Board only $4.50; with parts $7.00

VERBATIM™ FLOPPY DISKS

5¼ in. Minidiskettes
Soft sector, 10 sector, or 16 sector
$4.40 each or box of 10 for $40.00
8 in. Standard Floppy Disks
Soft Sector
$4.75 each—10 for $42.50

FLOPPY DISK INTERFACE

JADE FLOPPY DISK (Tarbell board)

Kit	$175.00
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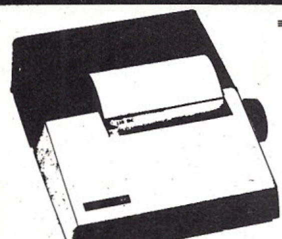
S.D. Computer Products
VERSA-FLOPPY

Kit	$159.95
Assembled & Tested	$239.00

TRENDCOM 100 Intelligent Printer



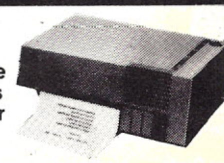
$345

Interface & Cable for TRS-80
$45.00

Interface & Cable for Apple
$60.00

- 40 character per second rate
- Low cost thermal paper
- 96 character set
- Microprocessor controlled
- Bidirectional look-ahead printing
- Quiet operation
- No external power supplies
- Only two driven parts
- High reliability
- Clear 5 x 7 characters
- Attractive metal and plastic case

Integral Data Systems INC



Check the impressive features on Integral's IP-125 Impact Printer
only **$799**

LOADED WITH EXTRAS AT NO EXTRA COST

▪ Microprocessor controller ▪ Serial RS232C Interface ▪ Parallel TTL level interface ▪ Full upper and lower case ASCII character set (96 characters) ▪ Full 8½" inch wide paper ▪ Line length of 80 columns at 10 characters per inch ▪ Impact printing ▪ 7x7 dot matrix ▪ Ordinary paper—roll, fanfold, or sheet ▪ Serial baud rate to 1200 bits per second ▪ Multiple line buffer of 256 characters ▪ Instantaneous print rate to 100 characters per second ▪ Multiple copies without adjustment ▪ Reinking ribbon mechanism ▪ Front panel operator controls ▪ Attractive table top console

IP-125 **Integral Data System IP-125 Friction Feed Printer**
- 96 upper & lower case ASCII character set
- Enhanced character control
- Serial RS232C Interface (std. factory wiring)
- Parallel TTL Interface (factory wired on req.)
- 80 column line
- 256 byte multiline buffer

$799

IP-225 **Integral Data System IP-225 Tractor Feed Printer**
- All standard features of IP-125
- Tractor feed paper drive
- Forms Control Option (P1250)

$949

EXPANDOR'S BLACK BOX PRINTER

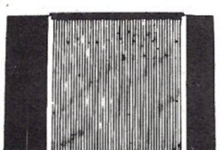
This 64-character ASCII impact printer with 80-column capability is portable and uses standard 8½" paper and regular typewriter ribbon. Base, cover and parallel interface are included. Assembled and complete with manual and documentation. **only $470.00**

(90 day manufacturer's warranty)

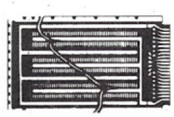
TRS-80 Interface Cable for Black Box Printer
with mating connectors: **$48.00**
(must be used with expansion module, +8v/1 amp power supply required.)

Power Supply for TRS–80/Black Box Printer **$49.00**

Vector Plugboards



3690-12
CARD EXTENDER
Card Extender has 100 contacts, 50 per side on .125 centers. Attached connector is compatible with S-100 Bus Systems . . **$25.00**
3690 6.5" 22/4 pin, 158 ctrs. Extenders **$12.00**



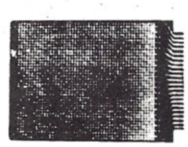
Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156.

3677 9.6" x 4.5" **$10.90**
3677-2 6.5" x 4.5" **$9.74**

8800V
Universal Microcomputer/processor plugboard. Use with S-100 bus. Complete with heat sink & hardware. 5.3" x 10" x 1/16".

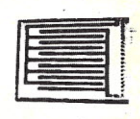
8801-1
Same as 8800V except plain; less power buses & heat sink.

	1-4	5-9	10-24
8800V	19.95	17.95	15.96
8801-1	14.95	13.46	11.96



P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156.

3662 6.5" x 4.5" **$7.65**
3662-2 9.6" x 4.5" . . . **$11.45**



Hi-Density Dual-in-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156.

3682 9.6" x 4.5" **$10.97**
3682-2 6.5" x 4.5" **$9.81**

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LEEDEX MONITOR
- 12" Black and White
- 12MHZ Bandwidth
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$139.00

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Low price includes KIM-1 Module monitor programs stored in 2048 ROM Bytes User Manual wall size Schematic Hardware Manual Programming Manual Programmers Reference Card Keyboard Display

THE SYM-1 $245
6502 — based single board computer with keyboard/display, KIM-1 hardware compatible, complete documentation.

SYM-1 CASE $29.95

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F8		$16.95
Z80 (2MHz)		$20.00
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6800		$16.95
6802		$25.00
8008-1		$12.95
8035		$20.00
8035-8		$21.00
8080A		$10.00
8085		$23.00
TMS9900TL		$49.95
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8212		$ 2.90
8214		$ 4.65
8216		$ 2.75
8224 (2MHz)		$ 4.30
8224-4 (4MHz)		$ 9.95
8226		$ 2.75
8228		$ 6.40
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8253		$20.00
8255		$ 6.45
8257		$20.00
8259		$20.00
8275		$75.00
8279		$18.50
USRT		
S2350		$10.95
UARTS		
AY5-1013A		$ 5.25
AY5-1014A		$ 8.25
TR1602B		$ 5.25
TMS6011		$ 5.95
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MC14411		$10.00
14411 Crystal		$ 4.95
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6820P		$ 6.60
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6828P		$11.25
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6860P		$ 9.25
6862P		$12.00
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2708		$ 9.95
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TMS4027/4096 (300ns)		$ 4.00
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21L02 (250ns)	$ 1.75	$ 1.50
2101-1	$ 2.95	$ 2.60
2111-1	$ 3.25	$ 3.00
2112-1	$ 2.95	$ 2.65
FLOPPY DISK CONTROLLERS		
1771B01		$39.95
1791		$49.95
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AY5-2376		$13.75
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MM5740		$18.00

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Naked Terminal

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- Industry standard 80 character by 24 line format (Model 57)
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- No support software required.
- Switch selectable modes: Half Duplex, Full Duplex, Block mode.
- Block mode allows editing before transmit.
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- Video is switch selectable as "Black-on-White" or "White-on-Black".
- Fully assembled, socketed, tested, burned in, and guaranteed for a full year from date of purchase.

$350.00
with cables

NEW!
JADE Z80 BOARD
IMPROVED DESIGN AND FEATURES
- ON BOARD 2708 or 2716 EPROM
- VERY RELIABLE AT 4 MHZ OR 2 MHZ
- POWER ON JUMP AND RESET
- ON BOARD USART (8251)

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Kit	$135.00
Assembled & Tested	$185.00
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Kit	$149.95
Assembled & Tested	$199.95
Bare Board	$ 35.00

JADE 8080A
with full documentation

Kit	$100.00
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JG8/16 (uses 2708 or 2716) **$69.95**

Jade Memory Expansion Kits for TRS-80 and Apple!
4116's
8 for $69.96
(16K x 1, 200ns)
includes dip plugs and instructions

★TRS-80 Kit★
(16K x 1, 300ns)
includes connectors and instructions
$75.00
Call for discounts on larger quantities

"IMSAI"-TYPE CARD GUIDE SPECIAL:
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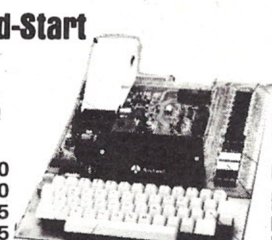
Rockwell AIM-65: The Head-Start in Microcomputers



A KIM-1 compatible machine with on-board printer and a real keyboard!

$375.00 w/1K RAM
$450.00 w/4K RAM

4K assembler/editor in ROM:	$ 80.00
8K BASIC in ROM:	$100.00
Power supply:	$ 59.95
Case for AIM-65:	$ 49.95

Special Package Price: $599.00
AIM-65 (4K), Power Supply, Case, and 8K BASIC ROM

New Prices
DYNAMIC RAM BOARDS EXPANDABLE TO 64K

32K VERSION • KITS
Uses 4115 (8Kx1, 250ns) Dynamic RAM's, can be expanded in 8K increments up to 32K:

8K	$159.00	24K	$249.00
16K	$199.00	32K	$299.00

4115 SALE
8 for $39.95

64K VERSION • KITS
Uses 4116 (16Kx1, 200ns) Dynamic RAM's, can be expanded in 16K increments up to 64K:

16K	$249.00	48K	$469.00
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KIMSI
INTERFACE/MOTHERBOARD
Makes S-100 cards plug-in compatible with KIM!

Kit	$125.00
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BETSI
INTERFACE/MOTHERBOARD
Makes S-100 cards plug-in compatible with PET!

Kit	$119.00
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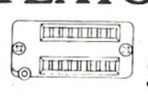
The Piggy™ is here!

SEE OUR COLOR AD IN APRIL'S BYTE

TEXTOOL ZIP* DIP® II Sockets



***ZERO INSERTION FORCE sockets**

PRICES:

16 pin Zip Dip II	$5.50
24 pin Zip Dip II	$7.50
40 pin Zip Dip II	$10.25

★ STATIC RAM SPECIALS ★

2114's, low power (1024x4)

	1-15	16-99	100 +
450ns	8.00	6.95	5.50
300ns	9.00	8.00	6.50

TMS4044/MM5257, low power

450ns	8.00	7.50	6.50
300ns	9.95	8.75	8.00

4200A (4Kx1, 200ns)

9.95	8.50	8.00

410D (4K x 1, 200 ns)

8.25	7.00	6.75

STATIC RAM BOARDS

JADE 8K

Kits:	450ns	$125.95
	250ns	$149.75
Assembled & Tested:	450ns	$139.75
	250ns	$169.75
Bare Board:		$ 25.00

16K — Uses 2114's (low power)
Assembled & Tested:

RAM 16 (250ns)	$375.00
RAM 16B (450ns)	$325.00

16K with memory management
Assembled & Tested:

RAM 65 (250ns)	$390.00
RAM 65B (450ns)	$350.00

32K Static
Assembled & Tested:

250ns	$795.00
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250ns Kit	$575.00

JADE Computer Products ✓J6

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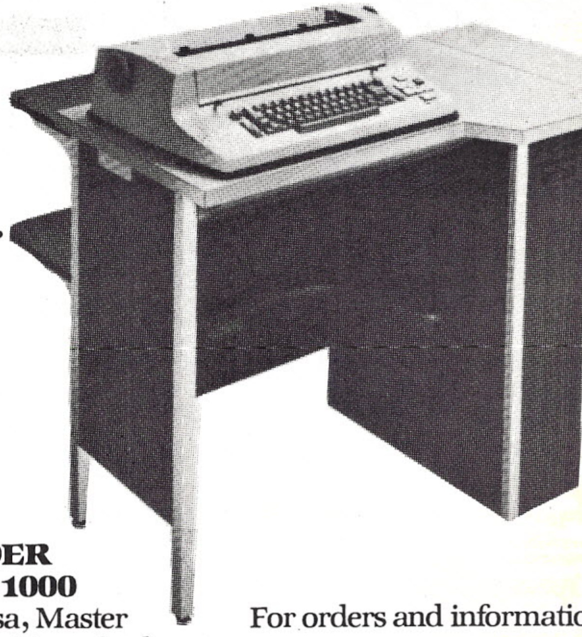
All prices subject to change without notice.

The DATA-TRANS 1000

A completely refurbished
IBM Selectric Terminal
with built-in ASCII Interface.
$1495.00. For a limited time
save **$100.00** on each unit ordered.
Now, until April 30, 1979
Only $1395.00



Features:

- 300 Baud
- 14.9 characters per second printout
- Reliable heavy duty Selectric mechanism
- RS-232C Interface (requires RS-232C port for I/O transmission)
- Documentation included
- 60 day warranty - parts and labor
- High quality Selectric printing Off-line use as typewriter

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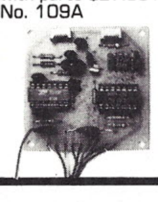
MODEM✲

● Type 103 ● Full or half duplex ● Works up to 300 baud ● Originate or Answer ● No coils, only low cost components ● TTL input and output-serial ● Connect 8 Ω speaker and crystal mic. directly to board ● Uses XR FSK demodulator ● Requires +5 volts ● Board only $7.60 Part No. 109, with parts $27.50 Part No. 109A



APPLE II✲ SERIAL I/O INTERFACE

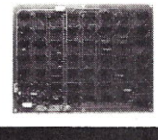
Baud rate is continuously adjustable from 0 to 30,000 ● Plugs into any peripheral connector ● Low current drain. RS-232 input and output ● On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even ● Jumper selectable address ● SOFTWARE ● Input and Output routine from monitor or BASIC to teletype or other serial printer ● Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. ● Board only $15.00 Part No. 2, with parts $42.00 Part No. 2A, assembled $62.00 Part No. 2C

UART & BAUD RATE GENERATOR✲

● Converts serial to parallel and parallel to serial ● Low cost on board baud rate generator ● Baud rates: 110, 150, 300, 600, 1200, and 2400 ● Low power drain +5 volts and -12 volts required ● TTL compatible ● All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. ● All connections go to a 44 pin gold plated edge connector ● Board only $12.00 Part No. 101, with parts $35.00 Part No. 101A, 44 pin edge connector $4.00 Part No. 44P

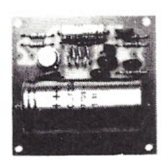
T.V. TYPEWRITER

● Stand alone TVT ● 32 char/line, 16 lines, modifications for 64 char/line included ● Parallel ASCII (TTL) input ● Video output ● 1K on board memory ● Output for computer controlled curser ● Auto scroll ● Non-destructive curser ● Curser inputs: up, down, left, right, home, EOL, EOS ● Scroll up, down ● Requires +5 volts at 1.5 amps, and -12 volts at 30 mA ● All 7400, TTL chips ● Char. gen. 2513 ● Upper case only ● Board only $39.00 Part No. 106, with parts $145.00 Part No. 106A



T.V. INTERFACE

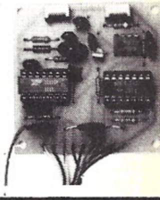
● Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple ● Power required is 12 volts AC C.T., or +5 volts DC ● Board only $7.60 part No. 107, with parts $13.50 Part No. 107A



(Illegal where prohibited by law.)

TAPE✲ INTERFACE

● Play and record Kansas City Standard tapes ● Converts a low cost tape recorder to a digital recorder ● Works up to 1200 baud ● Digital in and out are TTL-serial ● Output of board connects to mic. in of recorder ● Earphone of recorder connects to input on board ● No coils ● Requires +5 volts, low power drain ● Board only $7.60 Part No. 109, with parts $27.50 Part No. 109A



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✲ Circuits designed by John Bell

For free catalog including parts lists and schematics, send a self-addressed stamped envelope.

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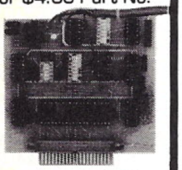
HEX ENCODED KEYBOARD
E.S.

This HEX keyboard has 19 keys, 16 encoded with 3 user definable. The encoded TTL outputs, 8-4-2-1 and STROBE are debounced and available in true and complement form. Four onboard LEDs indicate the HEX code generated for each key depression. The board requires a single +5 volt supply. Board only $15.00 Part No. HEX-3, with parts $49.95 Part No. HEX-3A. 44 pin edge connector $4.00 Part No. 44P.

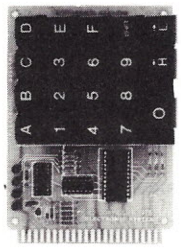


EIA/RS-232 connector Part No. DB25P $6.00, with 9', 8 conductor cable $10.95 Part No. DB25P9.

3' ribbon cable with attached connectors to fit TRS-80 and our serial board $19.95 Part No. 3CAB40.

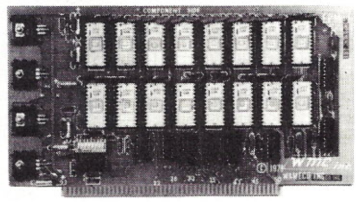
E.S. TRS-80 SERIAL I/O

• RS-232 compatible • Can be used with or without the expansion bus • On board switch selectable baud rates of 110, 150, 300, 600, 1200, 2400, parity or no parity odd or even, 5 to 8 data bits, and 1 or 2 stop bits. D.T.R. line. Board only $19.95 Part No. 8010, with parts $59.95 Part No. 8010A, assembled $79.95 Part No. 8010C. No connectors provided, see below.



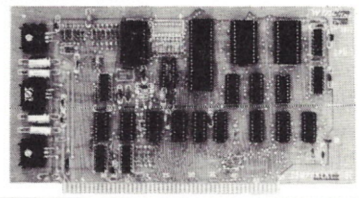
4K EPROM
WMC inc.

This board is designed to operate with any speed or power 1702A. Addressable in 4K byte increments and can be configured to occupy either 2K or 4K segments. It can be populated one memory chip at a time. Bare board $30, board with parts $200, assembled $230. Part No. EPM-1



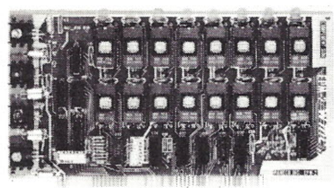
8080A CPU (With Eight Level Victor Interrupt Capability)
WMC inc.

Uses the 8080A and the 8224 clock chip. The crystal frequency used is 18 MHz and the vector interrupt chip is the 8214. The board will function normally without the interrupt circuitry. When the interrupt circuitry is built up, the board will respond to eight levels of interrupts. Designed to be a plug-in replacement for the IMSAI CPU board and will work in other computers with the appropriate modifications made to the ribbon cable connector pin out from the front panel. The board will work in systems without a front panel if the system has a PROM board that simulates the functions of the front panel. Bare board $30, with parts $185, assembled $220. Part No. CPU-1



16K OR 32K EPROM
WMC inc.

Designed to operate with any speed or power 2708 or single voltage (+5V) 2716. Addressable in 4K increments and can occupy multiples of 4K. It can be populated one memory chip at a time. Has bank addressing and Phantom Disable. The board comes with an exclusive software program that can be placed in a 2708 or 2716 that will, when used in conjunction with a RAM memory board, check out every line on the EPM-2. Bare board $30, board with parts with 2708 $455, assembled $485. Board with parts with 2716 $1,225, assembled $1,255. Part No. EPM-2

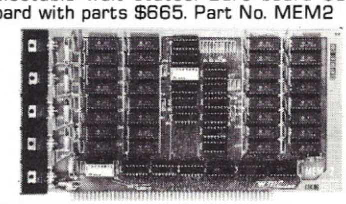


S-100 BUS ACTIVE TERMINATOR *

Board only $14.95 Part No. 900, with parts $24.95 Part No. 900A

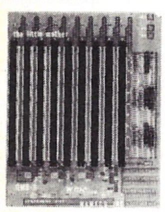
16K STATIC RAM
WMC inc.

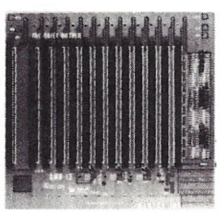
Operates with any speed or power 2114. All input and output lines are fully buffered. Addressable in 4K byte increments. If the system has a front panel, the board will allow itself to be protected. If there is no front panel, the board will not allow itself to be protected. The board has Bank Address capability, Phantom Disable, MWRITE, and selectable wait states. Bare board $30, board with parts $665. Part No. MEM2



9 AND 13 SLOT MOTHER BOARDS
WMC inc.

All traces are reflow solder covered and both sides are solder masked. The connectors used on these boards are the IMSAI™ type (.125" between pins, .250" between rows). Spacing between connectors is .750". All lines, except power and ground, have a passive RC network termination available. There is a kluge area available that will accept two 40 pin sockets and one 36 pin socket. The circuitry for supplying three separate regulated voltages to the kluge area is contained on the board. Part No. QMB-12 $40 bare, $105 kit, $120 assembled. Part No. QMB-9 $35 bare, $90 kit, $105 assembled.





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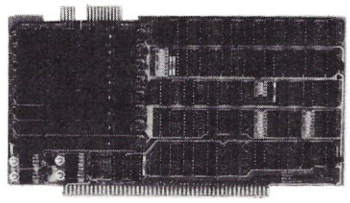

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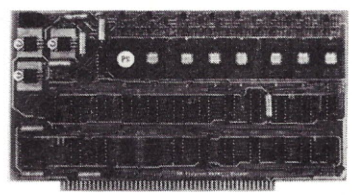
PIICEON

Saves programs on PROM permanently (until erased via UV light) up to 8K bytes. Programs may be directly run from the program saver such as fixed routines or assemblers. • S-100 bus compatible • Room for 8K bytes of EPROM non-volatile memory (2708's). • On-board PROM programming • Address relocation of each 4K or memory to any 4K boundary within 64K • Power on jump and reset jump option for "turnkey" systems and computers without a front panel • Program saver software available • Solder mask both sides • Full silkscreen for easy assembly. Program saver software in 1 2708 EPROM $25. Bare board $35 including custom coil, board with parts but no EPROMS $139, with 4 EPROMS $179, with 8 EPROMS $219.



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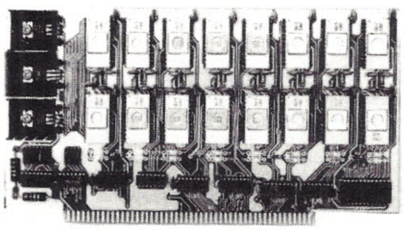

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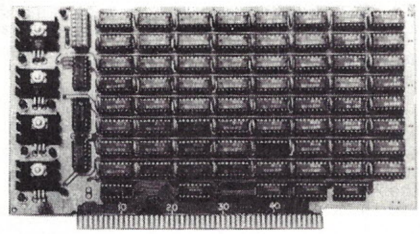

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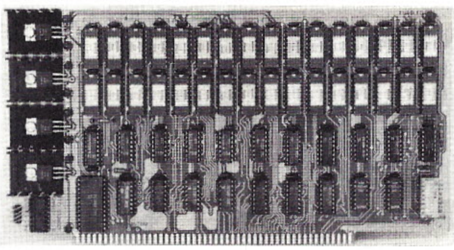

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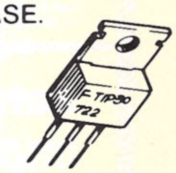

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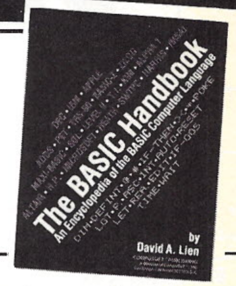

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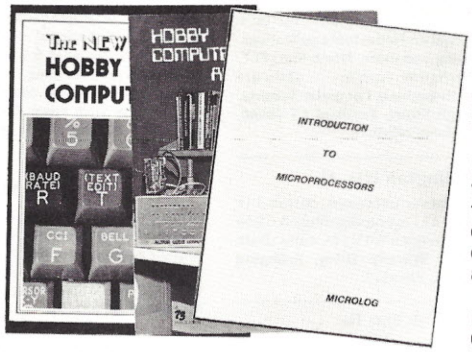

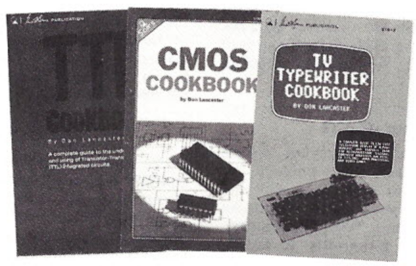

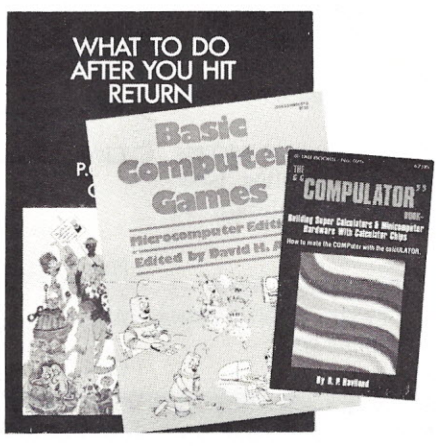

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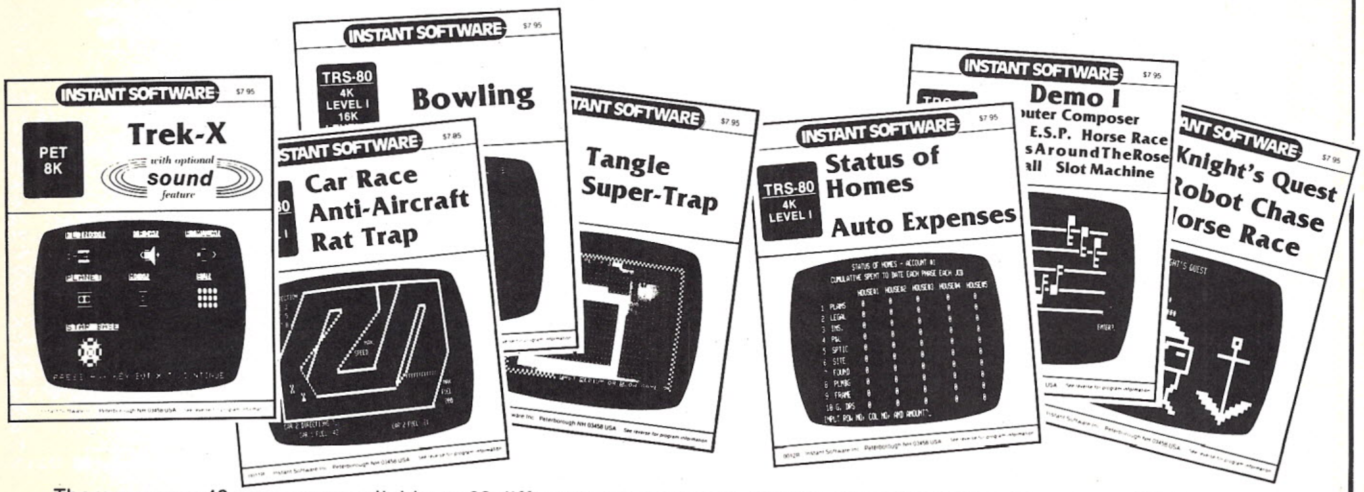

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